VOL. XIII, NO. 3 JULY, 1931 O'd Series Vol. XXIX, NO. 3

The Journal of Bone and Joint Surgery

PRESIDENTIAL ADDRESS*

BY WILLIS C. CAMPBELL, M.D., MEMPHIS, TENNESSEE

There has been much written regarding the evolution and progress of Orthopaedic Surgery, but very little consideration has been given to the possible development of this branch in the future and how we may, in any manner, direct such progress by some definite organized effort on our part.

The American Orthopaedic Association has been the most dominant factor in fostering the development of orthopaedic surgery, not alone in America, but elsewhere. Either officially or unofficially, the members have been active in establishing Orthopaedic Sections of the American Medical Association and Southern Medical Association, and other orthopaedic clubs for the study and advancement of our specialty. Also, this Association has evolved one of the best medical journals in the country, which undoubtedly is recognized as being the leading periodical on the subject. This has been accomplished by the vision and forethought of our efficient Editor and contributions from the members of the Association. The actual progress as to the increase in our assets and in the circulation is well known. However, no special journal can ever be placed on a sound financial basis, and, at the same time, be able to produce the character of publication desired for the reproduction of scientific data. As our Journal is a splendid type of research for the benefit of humanity, there is no reason why an endowment fund should not be established for this purpose. This has recently been accomplished in other journals, as the *American Journal of Cancer*. The question may be raised as to the propriety of this Association establishing such a fund; but when we think of the problem in its true light, there is no difference between the function of our Journal and any other type of scientific investigation, which is largely supported by the aid of laymen.

Orthopaedic surgery is one of the youngest specialties, and has developed so rapidly during the past decade as to become firmly established and recognized by the profession and the public. The modern orthopaedic surgeon can no longer be referred to as a mechanic and gymnast, but is a well trained scientist in the medical and surgical management of those

*Read at the Annual Meeting of the American Orthopaedic Association, Memphis, Tennessee, April 17, 1931.

injuries and affections of the bones, joints, muscles, nerves, etc., which may cause disability and deformity at any age. The time has now arrived in the development of orthopaedic surgery to discuss how the future progress may be directed to the best interests of all concerned. This will be considered,—first, from a purely scientific standpoint; secondly, from the status of orthopaedic surgery as related to the State and to medicine and surgery.

In the address of my eminent predecessor, Dr. Adams, a more systematic method of investigation of the many scientific problems was suggested, which would be of inestimable benefit in evaluating various ideas and methods and in adding much knowledge to the subject. This Association has made remarkable progress, not alone by individual contributions, but by the various commissions for the investigation of the results of the methods employed in the treatment of certain conditions,—as scoliosis, paralytic feet, and congenital dislocations of the hips. The splendid achievements of those composing these committees are well known and require no further commendation. But, as in all other surgical associations, our deliberations are often demonstrated by the lack of cooperation between the physiologist, the pathologist, and the practical surgeon. If surgery is to advance, it must be to a large extent through the principles of physiology, especially as related to function. If we will reflect, we have reached our zenith in all branches of surgery. From a mechanical standpoint, organs have to be removed, cross-circuited, transferred, and grafted, and, by experience, the technique of procedure has been largely standardized; therefore, future advancement must be, to a great extent, in some other manner.

The membership of this Association is composed of men vitally interested in every phase of orthopaedic surgery,—physiology, pathology, physiotherapy, as well as practical surgery. Various commissions could be formed of those more interested in certain subjects, to be continued indefinitely, each year meeting together to discuss new contributions and their individual experiences, and reporting to the Association from time to time when important knowledge has been acquired. For instance, there could be standing commissions on fractures, physiology of bone, bone tumors, and various phases of surgical pathology. These committees would, of course, cooperate with others in their respective fields, as the Sarcoma Registry of the American College of Surgeons. There is no group of surgeons who have had so large an experience in bone tumors as orthopaedic surgeons, and yet we have contributed very little to the literature on that important subject.

A central bureau of literary research would be, if established, of inestimable value to the advancement of orthopaedic surgery. In fact, to obtain accurate bibliographies is often quite difficult for those who do not have access to libraries in the large cities. And, usually, the professional collaborator does not possess the slightest conception of the data required. There are too frequently gross inaccuracies in bibliographies of published

articles and often in statements made by authors. The expenditures by members of this Association and others for this purpose would easily perpetuate a central bureau, with collaborators expert in this field, where accurate information could be obtained and in time collected papers and abstracts could be accumulated for reference. The accumulated abstracts of those who, for years, have contributed to "The Progress in Orthopedic Surgery" (published in *Archives of Surgery*), would form an excellent nidus, and, undoubtedly, if copies of articles from the files of many others could be obtained, a vast resource would be secured at once. Such a bureau might possibly be established at comparatively little expense in connection with The Journal or associated with the American College of Surgeons who already are making extensive efforts in research literature. This, of course, would be a matter of detail to be decided after due consideration.

There should be an organized effort on our part to standardize the training of the orthopaedic surgeon, which at present is entirely in the hands of the candidate himself. As is well known, there are no legal requirements regulating specialists in any field, and, in consequence, many have entered the various specialties of medicine totally unprepared and ignorant of the requirements essential to the experts which they claim to be. Those more conscientious have given sufficient time and study to the subject, but in the absence of the proper guidance their training is often unbalanced. Other specialties, as opthalmology and the ear, nose and throat, have made material advance in this direction, by making definite requirements of a more systematic manner of training and by establishing examining boards to determine qualifications of applicants. Any attempt at the present time to outline a method of education for the orthopaedic surgeon would be premature, for obviously the evolution of a well-balanced system of training can only be accomplished by much deliberation and probably considerable experience; in consequence, the subject can only be discussed in a very general manner. The candidate, after graduation from medical college, should first receive a broad training in the principles of general medicine and surgery as an intern in an approved hospital, after which a period of at least two years should be given to a systematic investigation of orthopaedic surgery. The first six months could be employed largely in the laboratory with special reference to physiology and surgical pathology; sufficient time should be given to the medical side of the subject, for many of the problems are often more medical than surgical. Time should also be spent in the brace department, for each surgeon should understand the basic principles in the making of braces and splints. Operative technique is of less consequence, as this can always be acquired by experience. The development of diagnostic acumen and surgical judgment is of prime importance, and should receive the most careful attention. The recognition by the medical profession of the necessity for standardization of specialties in various fields must be secured before real progress can be made. This should not be difficult, as it would be mani-

festly beneficial to the profession and the public. Possibly the real solution may be accomplished by law, as in the regulation of the practice of medicine, for the status is somewhat analogous.

Specialism in medicine is often criticized, but advancement of knowledge in medicine, as in all other subjects, has come almost entirely by specialization,—for instance, while Harvey and Haller were recognized general physicians of their day, in reality they were true specialists in their respective fields of physiology and histology. There are not too many specialties or specialists, but there are too many specialists too highly specialized. This development in medicine has been effected by an analogous evolution in business. For some there may be little excuse, but the problem is solved by natural selection or the survival of the fittest. There is also a continuous evolution in every specialty of work encountered. In orthopaedic surgery a decade or two ago, the treatment of tuberculosis of bones and joints constituted probably the most important subject, and much of the deliberations of this Association was given to descriptions of methods of applications of casts and other mechanical apparatus. One has only to contrast this with the subject matter in The Journal or the program of any meeting of the American Orthopaedic Association to note how great a change has been effected.

As the orthopaedic surgeon is so often involved in compensation problems connected with the insurance companies and the state, he is essentially interested more than any other specialist in laws regulating such cases. In many states these laws are manifestly unfair to the physician who does most of the work and assumes by far the largest part of the responsibility. Such a status is so obvious that the high-class insurance companies often disregard the law and adjust many cases on a more equable basis. However, the medical profession should not be dependent upon the mercy of any one, but should demand the settlement of this problem upon a basis fair and equable to all parties concerned.

State medicine at present is of paramount interest to the medical profession. This has made a greater advance in the care of cripples than in any other field of medicine, which does not appear to be recognized by the general medical profession. The orthopaedic surgeon has sponsored this and every other movement which appears to be for the benefit of the public, and possibly this has been for the best interest of all concerned. I do not desire to discuss any phase of state medicine on this occasion, but I do believe that earnest consideration should be given by us to this subject.

Individually, as orthopaedic surgeons, we are vitally interested in the present-day problems above mentioned. It is questionable whether such problems as state medicine and compensation laws would be within the scope of this Association, but they may be fostered by us and brought to the attention of other associations. In any event, the development of orthopaedic surgery has reached such a state in America that due consideration should be given to these and other problems, and an organized effort on our part should be made for the best interests of all concerned.

PATHOLOGY IN RELATION TO ORTHOPAEDIC SURGERY*

BY R. C. ELMSLIE, M.S., F.R.C.S., LONDON, ENGLAND

Orthopaedic Surgeon to St. Bartholomew's Hospital, and Consulting Surgeon to the Royal National Orthopaedic Hospital

Orthopaedic surgery deals largely with the physical defects of the body and limbs, and with the restoration of their functional use when this has been interfered with by deformity, disease, or injury. Much of the work is based upon a sound knowledge of mechanical principles, and requires a high degree of manual dexterity. It naturally tends to attract those who are keen on mechanics. The operative work requires an accurate knowledge of anatomy; the restoration of functional use requires familiarity with the physiology of movement. So that mechanics, anatomy, and physiology take leading places in the training of an orthopaedic surgeon, and the study of pathology is apt to be neglected. Opportunities for pathological work are, however, very frequent in orthopaedic surgery, and until recently these opportunities have not been utilized to the full. We have only to survey the conditions that we are treating daily to find numerous examples of conditions of which the pathology is still unknown or uncertain. There are, indeed, few fields in which there is such a large volume of work waiting to be done.

This is true of the pathology of muscles, tendons, and joints, but it is particularly true of the pathology of bone. This subject presents very great difficulties of technique, and this has possibly been a factor in delaying really accurate work. The extreme complexity of the tissues has also led to difficulties of interpretation and, I believe, to great misunderstanding. Similarities in the appearances of histological changes in the bones in different diseases have sometimes led pathologists to classify the diseases together, whereas the similarities are probably due to the fact that changes are taking place in one special but highly complex tissue. For example, the occurrence of osteoclastic absorption, of deposit of bone by osteoblasts, and fibrosis of the marrow in both osteitis deformans and fibrocystic disease has led competent pathologists to suggest that these two diseases ought to be classed together, although clinically they are totally distinct. We now know the exact pathology of one of these, and we are beginning to realize that all three of these changes may occur in bone as the result of many different pathological conditions.

Recent advances in biochemistry have opened up completely new lines of investigation in the pathology of bone, and have given a tremendous stimulus to this branch of work. We are now in a position to start

*Presidential Address delivered at the Meeting of the British Orthopaedic Association, November 28, 1930.

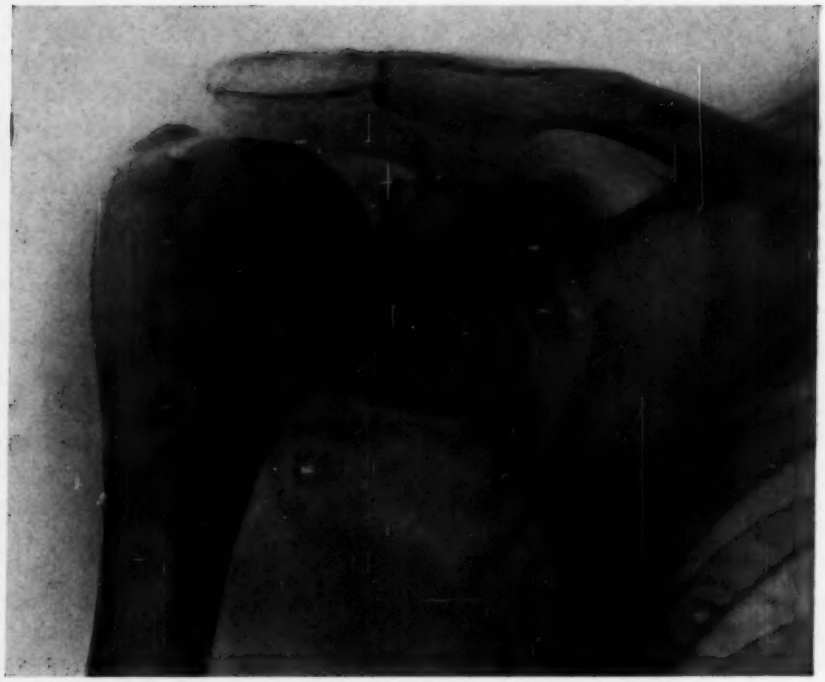

FIG. 1

Calcareous cyst of the supraspinatus following slight trauma.

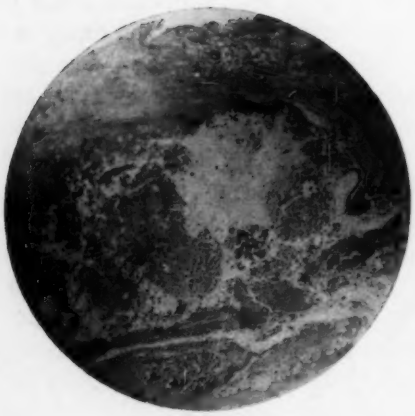

FIG. 2

Microscopic section of a calcareous cyst of the supraspinatus. Above: part of the tendon. In the centre: calcareous debris and inflammatory tissue.

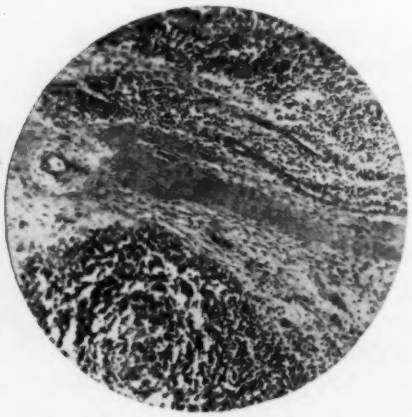

FIG. 3

Section of a compound ganglion from the dorsum of the hand. Across the center is a portion of the tendon, with inflammatory tissue above and below it.

FIG. 4

Synovial cyst of the knee joint showing small cysts still containing myxomatous tissue, but with the so called endothelial lining already formed, and adjoining these, an area of myxomatous degeneration.

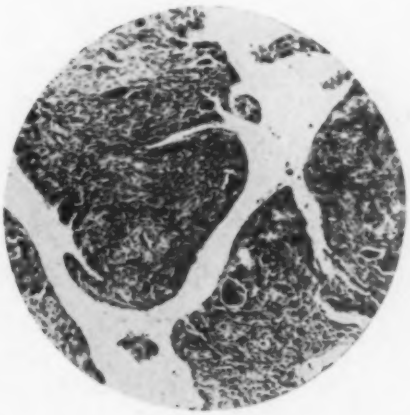

FIG. 5

Giant-celled new growth of the synovial membrane of the knee joint.

the investigation of all the general and local diseases of bone on entirely new lines, bringing into close cooperation the clinician, who will classify the condition according to its clinical type; the operator, who will investigate the bone as seen at operation and remove specimens for examination; the pathological histologist, who describes the microscopical changes present; and the biochemist, who investigates the variations from normal metabolic processes.

The fact that I spent five years in a pathological laboratory has naturally led me to take a special interest in the pathological aspects of my

FIG. 6

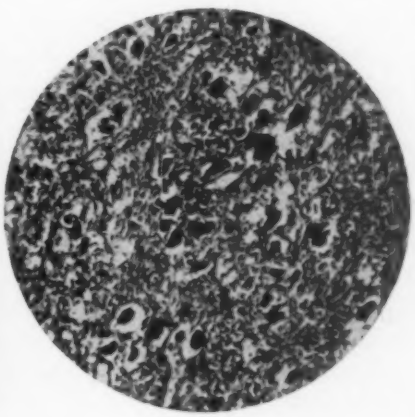

FIG. 7

X-ray and microscopic section of a benign giant-cell tumor (osteoclastoma) of the terminal phalanx of a finger.

FIG. 8

Enchondroma of the shaft of the humerus. (*Courtesy of British Journal of Surgery.*)

work. In bringing forward today a few things that we have learned, and many that we have to learn, I am hoping to indicate how much there is to be done, and to stimulate some among you to take part in further pathological research of orthopaedic conditions.

It has always seemed to me remarkable that such a highly differentiated tissue as muscle is subject to so few pathological conditions. Inflammation and new growth in the vast majority of cases invade muscle from without, and the changes occur chiefly in the interstitial tissue, the muscle fibers being only secondarily affected.

Ischaemic contraction presents an interesting problem, which has been investigated by Bristow and shown to consist of an aseptic necrosis of the muscle fibers, their removal by phagocytic action, and replacement by fibrous tissue. This work leads to the corollary that the damage is done by ischaemia in a very short time, and that this condition must be recognized very early if any of the muscle is to be saved. There are other conditions of fibrosis of muscle producing contracture which might be investigated on similar lines.

Traumatic myositis ossificans is another subject that will repay further work. Morley in 1913 investigated this condition, both in histological preparations obtained from a clinical case, and by its experimental production in animals. He showed that in the early stages the ossifying tissue showed the presence of cartilage, bone, and preosseous fibrous tissue, and that the muscle fibers were invaded and destroyed. He argued that there was a migration of osteoblasts into contused muscle and blood clot after destruction of the periosteum, and that the condition was essentially due to this destruction of the periosteum whereby its function as a limiting membrane to the growth of bone was lost. This led to his advising treatment by early excision of the bony and cartilaginous mass, combined with covering of the exposed bone with a graft of deep fascia, to prevent further migration of osteoblasts and consequent recurrence of the bony growth. This work seems to have obtained little publicity, and, as far as I know, the suggested method of treatment has not been given a good trial. The pathology thus described does not altogether explain the clinical history of many of the cases. Further investigation of traumatic myositis ossificans

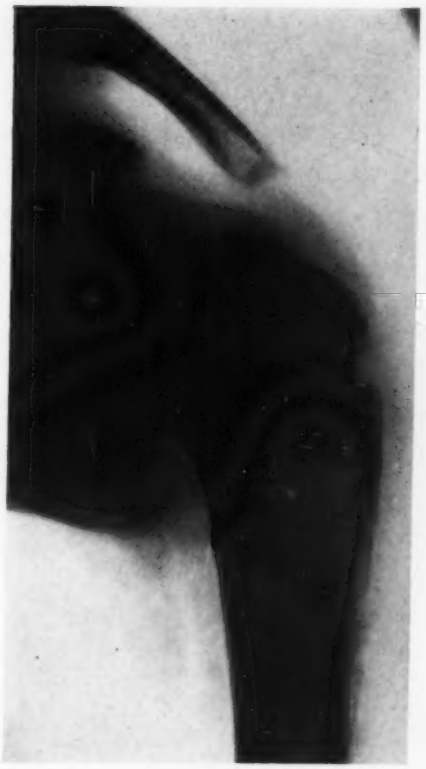

FIG. 9

X-ray of a myxoma of the shaft of the humerus.

FIG. 11

X-ray of a simple cyst of the shaft of the humerus, with a spontaneous fracture through it. (*Courtesy of British Journal of Surgery.*)

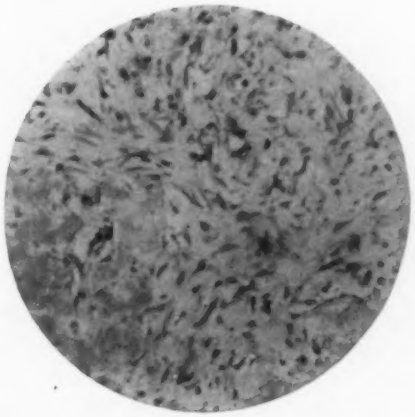

FIG. 10

Microscopic section of myxoma shown in Fig. 9.

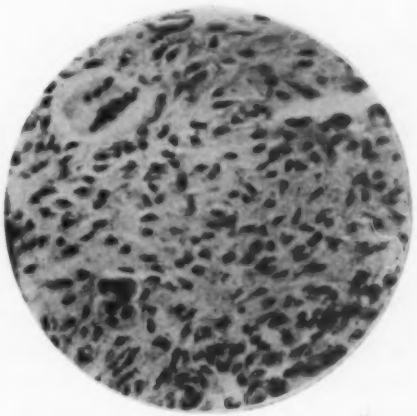

FIG. 12

Microscopic section of tissue curetted from the margin of the cyst shown in Fig. 11, containing a few giant cells.

FIG. 13

Osteoclastoma of the shaft of the humerus with a spontaneous fracture. (*Courtesy of Oxford University Press.*)

FIG. 14

Recurrence of cystic expansion of the bone above the level of the original osteoclastoma shown in Fig. 13—recurrent three years after curetting. This cyst contained only a little solid growth around its margins.

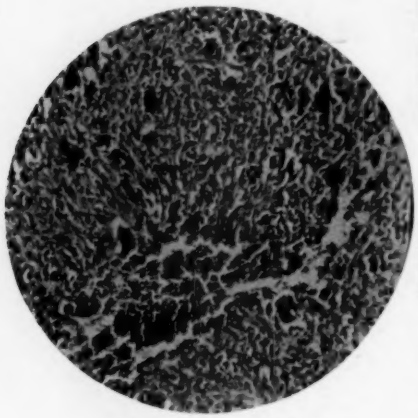

FIG. 15

Microscopic section of tissue removed from the cyst shown in Fig. 13.

is certainly called for, and such investigation must be carried out mainly by direct experimental work by the orthopaedic surgeon.

Another condition of which we still await an explanation is the calcareous cyst seen over the top of the great tuberosity of the humerus after certain shoulder injuries and causing a very characteristic shadow in an x-ray photograph. At operation this is found to consist of a small cavity lying in the attachment of the supraspinatus tendon and containing a deposit of calcium stearate. At certain stages there is an acute inflammatory reaction around this small cyst, which is the cause of intense pain. Often a small opening is found leading from the cyst

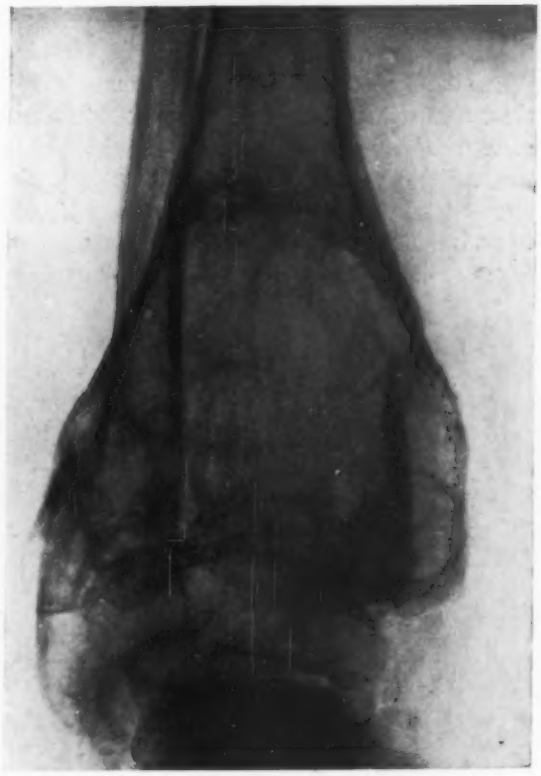

FIG. 16

Large expanding tumor of the lower end of the tibia, which was filled with solid growth, most of it bright yellow in color; treated by curetting. The ankle recovered, but five years later there was further enlargement of the bone, which was again curetted. (*Courtesy of Oxford University Press.*)

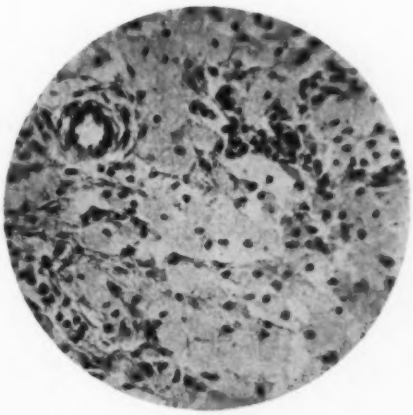

FIG. 17

Microscopic section of tissue removed from the tumor of the tibia shown in Fig. 16 at the first curetting, showing cells typical of a xanthoma. There were a few patches of giant cells also.

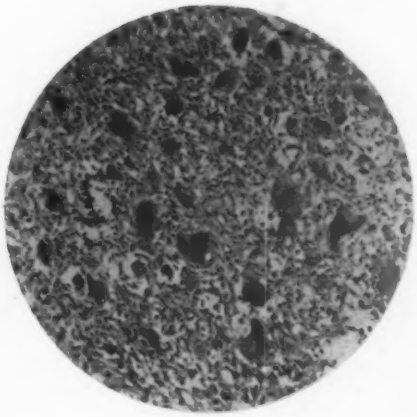

FIG. 18

Microscopic section of the tissue removed from the tumor of the tibia at the time of recurrence five years after the original curetting. The tissue is a typical osteoclastoma.

into the cancellous tissue underlying it. At the present time the pathology of the condition is a mystery.

Pathological lesions of tendons are also uncommon. Among the chronic inflammations must presumably be included the so called compound ganglion. This disease appears to start in the tendon sheath and mesotendon, and later to invade and destroy the tendon itself. Some of these cases are tuberculous, but many are not. The latter are presumably due to an inflammatory process of unknown origin. They are often associated with some form of chronic arthritis of one or more joints.

FIG. 19

Spontaneous fracture of the humerus through an expanded area, which on exploration proved to be a mixed-cell sarcoma.

When we come to a consideration of the pathology of joints, we find that a vast amount of work has so far helped us very little with the obscure subject of the pathology of the chronic forms of arthritis. I cannot help feeling that here there has been too little spade work. There has not been any careful record of the exact changes found in cases of arthritis of known bacterial, toxic, or chemical origin. These observed changes might be of assistance in classification of the more obscure cases. Also, there has been too little coordination of the exact clinical type of a case of arthritis with the pathological changes found in the synovial membrane and the joint structures.

Synovial cysts of the knee joint have received a considerable amount of attention,

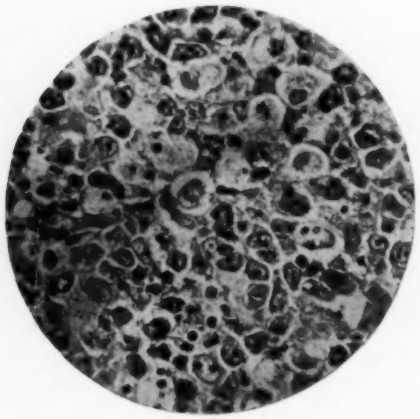

FIG. 20

Microscopic section of tissue removed from the humerus shown in Fig. 19. The arm was amputated, and the patient is alive and well five years afterwards.

and it has been shown that these originate in myxomatous degeneration of tissue, the appearance of the endothelial lining to the cyst being deceptive. In fact, the microscopic appearances may, perhaps, lead us to class these cysts as myxomata. Similar cysts occur in the synovial membrane of other joints. I have seen them in the superior tibiofibular joint and in the big toe joint. They may extend here outside the joint from which they arise, and it is at least possible that they should be classed with the ordinary simple ganglion. Cases classed as villous arthritis would appear to show very varying histological characters; some of them are definitely inflammatory, some even tuberculous, but in some the histological appearances suggest that the condition is a new growth of an innocent character. There is at least one definite form of diffuse new growth of the synovial membrane consisting of a spindle-celled stroma containing

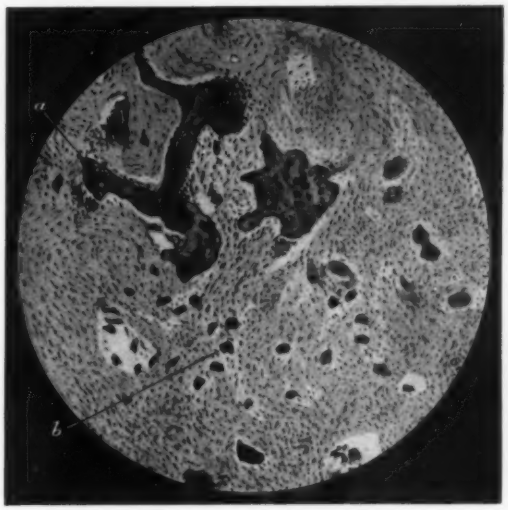

FIG. 21

Microscopic section from the central part of the tibia shown in Fig. 22: *a*. portions of bone; *b*. fibrous tissue containing numerous osteoclasts. (*Courtesy of British Journal of Surgery.*)

FIG. 22

X-ray of leg from a case of the fibrous form of fibrocystic disease affecting the middle of the shaft of the tibia. (*Courtesy of British Journal of Surgery.*)

FIG. 23

Microscopic section of the bone from a case of osteitis deformans, showing absorption by osteoclasts and fibrosis of the marrow.

FIG. 24

Case of late rickets with very great enlargement of the epiphyseal regions. (*From the St. Bartholomew's Hospital Reports.*)

FIG. 25

X-ray of the epiphyseal end of the radius from a case of late rickets.

FIG. 26

Microscopic section of bone removed from the femur in a case of late rickets, cut without decalcification: *a.* darkly stained calcified bone; *b.* lightly stained decalcified bone.

occasional giant cells which present similarities to the osteoclast. The growth is not unlike that which is occasionally seen in tendon sheaths.

To me, the pathology of bone forms the most fascinating field, a field so vast that I am constrained to pick out only one item. Some years ago I endeavored to show how the nature of a tumor or cyst occurring in the interior of a bone may perhaps be guessed by a consideration of the age of the patient, the clinical history, and the x-ray appearances. But at best, this is but a guess. An endosteal expansion of a phalanx of a finger is generally due to a chondroma or a myxoma, but other neoplasms may occur in this situation. I have seen an osteoclastoma of the terminal phalanx of a finger, and in generalized fibrocystic disease I have met with osteoclastoma of one of the phalanges of the thumb. Moreover, although chondroma and myxoma occur characteristically in the phalanges, they may be found in other situations. I have seen examples of both in the shaft of the humerus. In this latter situation most endosteal expansions are due to simple cysts, which may contain nothing but fluid, or may contain a little solid tissue in the margin. This tissue often contains numerous giant cells, which may give rise to doubt as to whether the case should be classed as a simple cyst or as an osteoclastoma. In some cases of cystic disease in the humerus there may be extensive changes in the bone, with the production of cartilage, of fibrous tissue, and of osteoid tissue. It is possible that these

FIG. 27

X-ray of the tibia from a case of generalized fibrocystic disease in which multiple fractures occurred.

FIG. 28

X-ray of lower end of right humerus from a case of generalized fibrocystic disease. (*Courtesy of Oxford University Press.*)

FIG. 29

X-ray of the upper end of the right radius from the same case.

FIG. 30

X-ray of the right tibia of the same case, showing remains of two old cysts and some generalized osteoporosis. (*Courtesy of Oxford University Press.*)

are all changes which are part of the production of the cyst, but it is possible also that they constitute a reaction in the surrounding bone.

A cystic expansion of the shaft of the humerus may consist of a typical osteoclastoma. In one such case that I have treated by curetting, the cavity apparently healed, but three years later recurred at a slightly higher level. On being reopened it was then found to be a cyst containing fluid, with only a little solid tissue in the margin. The latter, on histological examination, proved to be a typical osteoclastoma.

That an osteoclastoma can be transformed into a cyst by curetting was shown more definitely in another case in which a cavity in the lower end of the femur which contained a typical giant-cell tumor was curetted out and left for a year. At the end of this time the cavity was still to be seen in x-ray photographs, and was an evident source of weakness in the bone. It was therefore reopened, with a view to the insertion of a bone graft. It contained brown fluid only, and no trace of giant-cell tissue could be found in microscopic sections of its wall. After the insertion of bone grafts the cavity filled up with bony tissue.

FIG. 31

X-ray of the skull from the same case, showing great thickening of the calvarium. (*Courtesy of Oxford University Press.*)

This transformation of osteoclastoma into a cyst leads me to a further observation on the alteration in character of a bone tumor. A large growth expanding the lower end of the tibia was opened and thoroughly curetted. The contents was bright yellow in color and contained groups of cells characteristic of a xanthoma. The ankle made a good recovery, but at the end of five years a further expansion of bone occurred, leading to a second operation for curetting; the tissue removed on this occasion showed no cells of the xanthomatous type, but consisted entirely of a typical osteoclastoma.

To complete the list of tumors which may be found in the shaft of the humerus, a true sarcoma may occur in this situation. In one such case that I have seen, a spontaneous fracture occurred, but amputation of the limb resulted apparently in a cure, there being no recurrence or dissemination in five years.

Cystic conditions in the interior of bone may be associated with fibrous transformation of the neighboring bone or marrow, or such fibrous transformation may occur by itself. In microscopic sections of this condition

FIG. 32

Microscopic section of the parathyroid tumor found and removed from this case of generalized fibrocystic disease.

very dense fibrous tissue is found containing small spicules of bone, which later may show active osteoclastic absorption in some places and deposit of new bone in others. As already mentioned, the fact that similar changes occur in osteitis deformans has led some people to suggest that generalized fibrocystic disease and Paget's disease are closely related. It must, however, be wrong to class together two diseases which have such very definite and such different clinical pictures.

The changes that occur in single cysts, in cysts associated with neighboring fibrosis, and in the fibrotic expansions of bone are all similar histologically to those seen in various clinical types of generalized fibrocystic disease. This latter condition occurs in several definite clinical types, and in some of these the exact pathology has now been worked out by a combination of applied biochemistry and operative exploration. The pathology of the generalized diseases of bone has received a very great stimulus through recent advances in biochemistry, and particularly in investigations of calcium metabolism.

Twenty years ago I was collecting and investigating a series of cases of so called late or continued rickets,—that is, adolescents with marked bony deformities, enlarged epiphyseal regions showing characteristic cupping of the ends of the diaphysis, and without renal changes. In the case of one girl, I was obliged to remove a wedge of bone from the femur to correct a deformity. This bone showed marginal decalcification (halisteresis) to an extent that I have never seen in rickets. A biochemist investigated her calcium metabolism in 1914. He found that the blood calcium was low, and the calcium excreted in the urine was also low, and that no amount of increase in the calcium content of the diet produced any effect. In fact, as he said, she was incapable of absorbing sufficient calcium salts. Soon afterwards the same chemist came to me with x-rays of another patient, a young man suffering from repeated fractures. Here there was a different pathological picture. The blood calcium was high, the excretion in the urine high. The chemist informed me that he was absorbing calcium from his bones and excreting it. I at once recognized that the x-rays showed a generalized condition of fibrocystic disease. The former of these conditions is now recognized as coeliac rickets; the pathological condition is a failure to absorb fat and consequently also the fat soluble vitamins that are essential for the proper deposit of calcium in bone. The latter condition is now recognized as being due to excessive parathyroid activity.

In the case of a woman described fully by me in my article in the Robert Jones Birthday Volume, in whom multiple simple bone cysts with some osteoporosis and thickening of the skull occurred, I suggested in 1928 that a parathyroid tumor might be looked for. This year Mr. Dunhill operated and removed such a tumor, with the result that the blood calcium, which had been as high as sixteen milligrams per cubic centimeter at once dropped to nine milligrams per cubic centimeter, and all her bone pains ceased. We have yet to see what the result of the removal of this parathyroid tumor is upon the x-ray appearance of the bones. It is very remarkable that although the formation of cysts and decalcification of the bones was due to the presence of an excessive parathyroid activity, opening and curetting any individual cyst invariably resulted in a reformation of bone at this site.

Although there are already numerous recorded cases of generalized fibrocystic disease of bone in which parathyroid tumors have been found, yet we are only on the threshold of the investigations that must be carried out. There are several clinical and pathological types of this disease; there are the cases in which there are gross osteoclastomata in some of the bones, and the cases in which there are large areas of fibrosis. Are these cases of hyperparathyroidism? If so, why should such diverse pathological changes result from a single cause? And there are many other generalized bone diseases now open to combined clinical, pathological, and biochemical investigation. What of localized cystic disease, of puerperal osteomalacia, osteogenesis imperfecta, osteopsathyrosis, rachitic osteomalacia, and osteitis deformans? How fascinating are these problems, and with what added interest may we now continue our investigations with the assistance of the pathologist and the biochemist. Our assistance, the work of the clinician and the operator, is essential. The pure pathologist is a little apt to class cases together rather because they show similar pathological changes than because they present similar clinical characteristics. We must help in such clinical classification, and we must provide the observations and the material obtained by necessary operative interference, but we ought not to lose those opportunities for investigation which present themselves to us constantly in the course of our ordinary routine work.

THE TREATMENT OF CHRONIC OSTEOMYELITIS WITH THE MAGGOT (LARVA OF THE BLOW FLY)*

BY WILLIAM S. BAER, M.D., BALTIMORE, MARYLAND

Ever since the days of Pasteur and Lord Lister surgery has been basing its antiseptic and aseptic treatment upon their discoveries, and we have almost come to the belief that the antiseptic and aseptic techniques were purely on a chemical basis. During the late World War an observation which I made among the wounded soldiers led me to believe that the prevention of an infection, and the curing of an infection, could be brought about by means other than chemical. At a certain battle during 1917, two soldiers with compound fractures of the femur and large flesh wounds of the abdomen and scrotum were brought into the hospital. These men had been wounded during an engagement and in such a part of the country, hidden by brush, that when the wounded of that battle were picked up they were overlooked. For seven days they lay on the battlefield without water, without food, and exposed to the weather and all the insects which were about that region. On their arrival at the hospital I found that they had no fever and that there was no evidence of septicaemia or blood poisoning. Indeed, their condition was remarkably good, and if it had not been for their starvation and thirst, we would have said they were in excellent condition. When I noticed the extent of the wounds, of the thigh particularly, I could not but marvel at the good constitutional condition of the patients. At that time the mortality of compound fractures of the femur was about seventy-five to eighty per cent.—even when the wounded had the best of medical and surgical care that the Army and Navy could provide. Later, of course, the mortality was reduced as the splinting improved in the advance area, and when finally the splinting was made to a compound fracture of this nature where the men fell, the mortality was cut down to about twenty-five per cent.

Here, however, were two men in the earlier part of our engagement in the War, when the mortality of compound fractures of the femur was high, who, to all intents and purposes, were constitutionally well. This unusual fact quickly attracted my attention. I could not understand how a man who had lain on the ground for seven days with a compound fracture of the femur, without food and water, should be free of fever and of evidences of sepsis. On removing the clothing from the wounded part, much was my surprise to see the wound filled with thousands and thousands of maggots, apparently those of the blow fly. These maggots simply swarmed and filled the entire wounded area. The sight was very disgusting and measures were taken hurriedly to wash out these abominable looking creatures. Then the wounds were irrigated with normal salt solution and the most re-

*Read by Dr. Baer at the Annual Meeting of the American Orthopaedic Association, Chatham, Massachusetts, June 21, 1930. The final arrangement of this paper for publication has been completed since the death of Dr. Baer by his associate, Dr. George E. Bennett.

markable picture was presented in the character of the wound which was exposed. Instead of having a wound filled with pus, as one would have expected, due to the degeneration of devitalized tissue and to the presence of the numerous types of bacteria, these wounds were filled with the most beautiful pink granulation tissue that one could imagine. There was practically no bare bone to be seen and the internal structure of the wounded bone, as well as the surrounding parts, was entirely covered with the pink, rosy granulation tissue which filled the wound. Bacterial cultures were made and, while one found a few staphylococci and streptococci still remaining, they were very few in number and not sufficient at that time to cause a pus formation. These patients went on to healing, notwithstanding the fact that we removed their friends which had been doing such noble work.

The character of these wounds made such an impression upon me that I could not help but revolve the question in my mind for the next ten years, until I finally decided to put the observations made on the battlefield into practical use in civil surgery. There have been notes made by other military surgeons, notably, Larrey, Millingen, Keen, Zacharias, of the apparently harmless and perhaps beneficial effect of blow-fly infestation of war wounds, but no mention is to be found of any experimental or voluntary use of these scavengers in wound treatment in times of peace.* All of us

*D. J. Larrey, the famous military surgeon of Napoleon's armies, observes as follows in his Memoirs of Military Surgery (Translation by R. W. Hall, I, 177, 1814): "During the progress of suppuration, the patients were only troubled by worms or larvae of the blue flies common in Syria. The hatching of the eggs, which these flies constantly deposit in the wounds or dressings, was assisted by the heat of the weather and by the quality of the dressings, which were of cotton, which alone could be procured in this country. The presence of these insects in the wounds, appeared to accelerate their suppuration; but they caused a disagreeable pruritis, and obliged us to dress them three or f ur times a day. They are produced in a few hours, and increase with such rapidity, that in the course of a night they grow to the size of the barrel of a small quill. It is necessary, at each dressing, to use lotions of a strong decoction of rue with a small portion of sage, which destroys them but they were soon reproduced for want of proper means to prevent the approach of the flies and to destroy their eggs. Although these insects were troublesome, they expedited the healing of the wounds by shortening the work of nature, and causing the sloughs to fall off."

Larrey again mentions maggots, commenting as follows:—"In spite of the importunities of these insects they have accelerated the cicatrization of the wounds by abbreviating the work of nature and in provoking the destruction of scar tissue, which they destroy".

J. G. Millingen in his Curiosities of Medical Experience, American Edition, 1838, p. 171, says,—"During the retreat of our troops after the battle of Talavera (1809) I found the wounds of many of our men, that had not been dressed for three or four days, pullulating with maggots. This was not the case with the Spanish soldiers, who, to prevent this annoyance (which was more terrific than dangerous) had poured olive oil upon their dressings. I invariably resorted to the same practice when I subsequently had to remove the wounded in hot weather."

W. W. Keen says, "During the Civil War maggots were very common in summer—the resulting maggots were certainly disgusting but so far as I ever observed they did no harm."

Most interesting of all is a quotation from J. F. Zacharias of Cumberland, Md. who, as a surgeon in the Confederate Army, wrote as follows of his Civil War experiences:—"During my service in the hospital at Danville, Virginia, I first used maggots to remove the decayed tissue in hospital gangrene and with eminent satisfaction. In a single day they would clean a wound much better than any agents we had at our command. I used them afterwards at various places. I am sure I saved many lives by their use, escaped septicaemia, and had rapid recoveries."

Similar clinical observations were made by others in the World War, but no further investigation of the phenomenon was attempted by any one during the ten years following.

have had many cases of osteomyelitis, both in children and in adults, which have failed to heal under the antiseptic treatments which have been used from time to time. Whether treated by irrigation with mild bichlorid solution, or the packing with iodoform gauze, or the use of Dakin solution, or the use of secondary closure after a complete toilet of the wound, or immediate closure as recommended by Halsted, these cases have formerly recurred and recurred.

In September 1928 there were four cases of children that came into the hospital, each one of whom had been operated upon three or four times and treatment had covered a period of from one to five years. Being baffled in their cure by the means usually employed, I thought it was time to put into active use the observation that I had made on the battlefield. We, therefore, obtained the maggots from the blow fly from our immediate neighborhood and, without sterilization of the fly or maggot, we loaded the wound up with these maggots and proceeded to watch the results. It must be remembered that at this time no attempt was made to sterilize the maggot or the egg. We were copying, as we thought, the same conditions under which the maggots had performed their work on the battlefield. First a thorough operation was performed, with removal of all dead tissue, sequestra, devitalized muscle, fascial tags,—a complete macroscopic housecleaning of the region performed surgically. Nothing was used upon the skin of the patient except some slight scrubbing with normal salt solution, and no antiseptic whatsoever was brought in the neighborhood of the wound. The operation was done with the bare hands, washed only in water, and while no gloves were used, no iodin or any other chemical preparation was applied to the wound itself before operation. The idea was that, if the wounds healed up by means of the introduction of the maggot, the maggot alone would be responsible for the cure and no chemical agent could be said to have had anything to do with the result; and, if the wound healed, the maggot would not be injured or its activity decreased by bringing it in contact with any chemical substance. I realized the days on the battlefields and in the war hospitals could not be entirely reproduced, in that while on the battlefield the action of the maggot would be to prevent infection, in the cases now under treatment the action would be to cure infection. Nevertheless, at the end of about six weeks the wounds had entirely healed, not only in the deeper structures but even as to the skin.

As all the flies leave Baltimore about the fifteenth of October of each year for Florida and points south, we were unable to continue the treatment during that fall in many other cases, and so had to await the return of spring in order to carry on our experiments. In April and May 1929 further cases were submitted to this method of treatment and with the same results. Today we have eighty-nine cases which have been treated here in the City of Baltimore. An abstract of each will be given later in this paper.

It has been noted that in these early cases no sterilization was done. Owing to this fact we very unfortunately ran into certain secondary infec-

tions, particularly by anaerobes, such as tetanus bacillus and the gas bacillus of Welch. In the early experiments the Board of Trustees of the Children's Hospital School had the lawn in front of the hospital upturned so as to make a better sod. What was my surprise, therefore, when in three of the cases I found gas bacilli in the wound This was rather a disconcerting observation, yet one also noticed that the gas bacillus was doing no actual harm even though found in the wound. All experiments were discontinued until that difficulty had been overcome. Six guinea-pigs were given gas bacilli by traumatizing the part and having gas bacilli injected into the wound. All these specimens quickly succumbed to gas bacillus infection, and the gas bacilli were recovered from the organs of these pigs. Then six other guinea-pigs were inoculated with gas bacilli after bone and periosteal tissue had been markedly traumatized. The wounds through which the gas bacillus had been implanted were then sewed so as to make the conditions as anaerobic as possible. Twelve hours, sixteen hours, and twenty hours after the injections had been given these wounds were opened and the maggots introduced into the wound. Each and every one of these guinea pigs made a rapid recovery with complete function in the infected parts. The observation was therefore drawn that in order to overcome the gas bacillus one would only have to increase the number of maggots, provided the maggots were free of all gas bacillus when they were inserted into the wound. Treatment of patients was started again and a little later tetanus (lock-jaw) bacilli were found in about eight cases. All wounds were immediately washed out and all the patients thus infected were given doses of antitoxin. Four of the cases had no clinical symptoms but two of the cases went on to marked symptoms of lock-jaw. Both of these cases were of the severest type of osteomyelitis. One case of a colored man, who had tuberculosis of the ankle, tuberculosis of the lung, and tuberculosis of the spine, with a large abscess in the psoas region, died on the third day, notwithstanding the large amount of antitoxin he received. The other case had an extensive osteomyelitis of the right and left humerus and of the entire left femur. Large amounts of antitoxin were given through the small veins of the hand. Avertin was used to control the marked rigidity and spasm of the muscles and the patient finally made a complete recovery from the tetanus infection. This brought home to us the fact that in civil practice it would be necessary to have sterile maggots, and it would also be necessary to cultivate these maggots so that we might have a constant production of the larvae throughout both winter and summer time. They would have to be grown under our observation and under perfectly sterile technique. We also realized that, before sending these maggots out for use, the bacteriology of each group would have to be thoroughly studied and the maggots guaranteed free from the presence of all bacteria, both anaerobic and aerobic. This, therefore, took us into the field of the entomology of the blow fly. The flies selected for our use were the blue bottle fly and two varieties of the green bottle fly.

One had, therefore, to learn the life history of the fly,—its cycle of life; conditions under which it bred and laid its eggs; the conditions under which the eggs were laid as to temperature, as to moisture, as to the numerical proportion between the sexes. On what does the fly feed? Where and on what character of material does it lay its eggs? On what does the maggot feed? What is essential for its growth? How is it affected by sunlight? How is it affected by the lack of moisture? How is it affected in various temperatures, and so, on the whole, the problem of the growth of the fly, of the sterilization of the maggot, was a new and extensive undertaking and much experimentation had to be done. It was found that the best method of sterilization was to sterilize the egg. At first we tried to sterilize the maggot, and the maggot on its outside can be sterilized, but the maggot has an intestinal tract and the bacteria which were in the intestinal tract were contaminating the results even though the maggot on its outside had been made perfectly sterile. So finally it was determined that we could absolutely sterilize the surface of the eggs, that we could grow these sterilized eggs on sterilized food, and hence we could produce a sterilized maggot. Following is an account of the experiments and results obtained in the growing and sterilization of the maggot from the blow fly by Mrs. Elgin and myself. It must be remembered that now no batch of maggots leaves the laboratory until those maggots have been tested and found to be absolutely free of any bacteria.

HISTORICAL REVIEW

ANIMAL LIFE UNDER ASEPTIC CONDITIONS

Pasteur (1885) was the first to ask the question as to whether animal life is possible without the aid of micro-organisms. He believed that the question would be answered in the negative.

Nencki (1886) brought up theoretical considerations supporting the opposite view, reasoning that various digestive enzymes of the pancreas, stomach, and intestines split up the food into nourishing end products without the aid of bacteria, and that many or most of the end products of bacterial decomposition in the intestine,—such as indol, shatol, phenol, carbon dioxid, and carbon monoxid, are not foods and are actually harmful to the organism. He predicted that chickens, dogs, rabbits, or guinea-pigs might be successfully grown aseptically but he did not make any experimental tests.

In (1901) Mme. O. Metchnikoff raised sterile tadpoles of the frog, Rana temporaria.

Gelcourt and Guyenot in 1910 were the first to devise a method for rearing sterile larvae on sterile media.

In (1912) Cohendy experimented on chickens obtained from sterilized eggs. He compared the general condition and weight of (*a*) sterile chickens supplied with sterile air and food, (*b*) chickens from sterilized eggs, infected, and then fed with sterilized food and kept in conditions similar to those of *a*, and (*c*) chickens treated normally. The chickens of both *a* and *b* grew

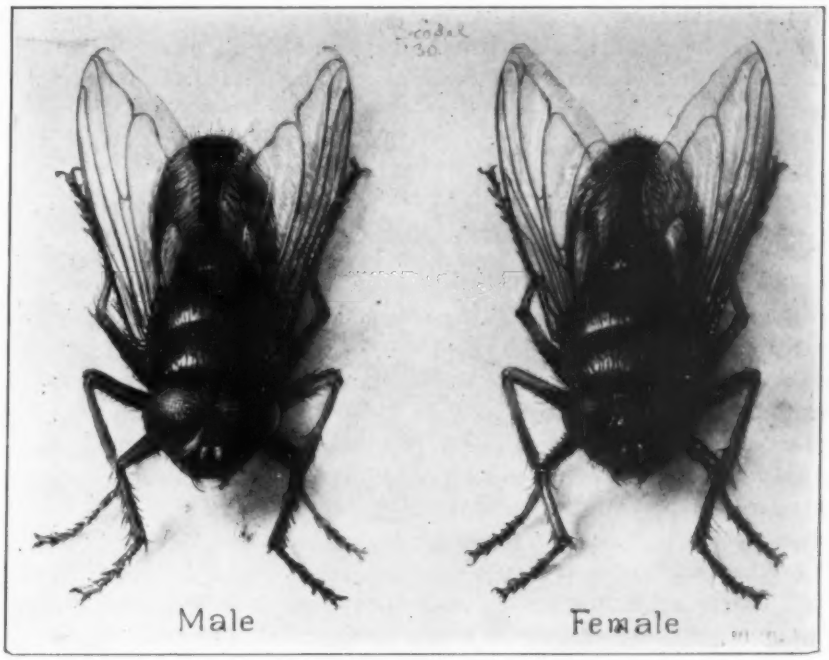

FIG. 1
Showing male and female fly.

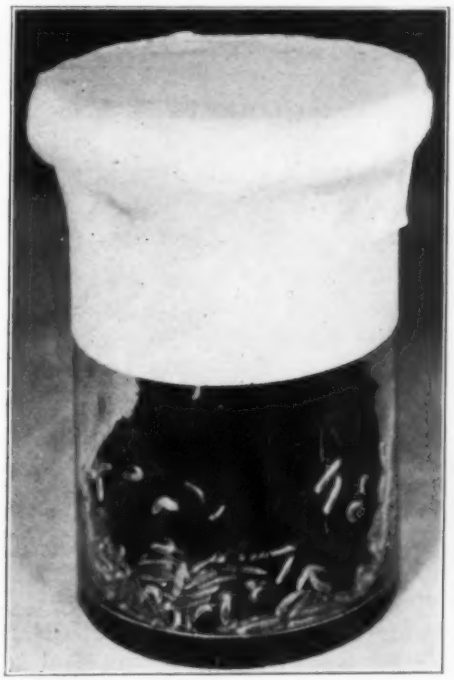

FIG. 2
Full-grown maggots.

FIG. 3
Container for sterile maggots.

FIG. 4
Test tube with applicator stick. Used as a container when sterilizing the eggs.

much less and were weaker than the normal chickens, but there was no great difference between the chickens of *a* and *b*, and he concluded that a complete absence of micro-organisms does not in itself entail any deterioration in higher vertebrates.

STUDIES ON BLOW FLY LARVAE

(Not Under Aseptic Conditions)

These larvae were secured during the summer by exposing raw beef outdoors, and when the flies had deposited a large mass of eggs the meat was transferred to a glass jar. The eggs hatched in eight to twenty-four hours, and the larvae were allowed to feed on the raw beef for two days. Water was then poured into the jar and the larvae would leave the meat. The water containing the larvae was then poured through a wire strainer and the larvae were collected with a small spoon and placed in bottles. The bottles were stopped with cotton wrapped in a fine grade of cheesecloth. The larvae were now ready to place in the patient's wound.

Cultures were taken from the wounds several days after the introduction of the maggots, and when studied were found to contain great numbers of gram negative bacilli, including bacillus coli, bacillus pyocyaneus, bacillus proteus vulgaris, and many spore-forming aerobes. A number of the cultures were found to contain anaerobic bacilli, such as bacillus tetani, bacillus Welchii, and bacillus sporogenes. Cultures were then taken from maggots and found to contain the same organisms.

We attempted to free the larvae or maggots from the pathogenic anaerobes by chemical sterilization. The larvae were immersed in full strength hydrogen peroxid and allowed to remain for two hours; following this they were immersed in bichlorid of mercury, strength one part in 1,000, for two hours. They were then washed in sterile distilled water. Cultures were made by allowing the larvae to crawl over a plate of sterile nutrient agar; and by streaking plates with the water that had been used in washing the larvae. Anaerobic cultures were also made from this water. These cultures were all negative. Some of the larvae treated in this manner were crushed and cultures made. These cultures were all positive for the gram negative bacilli as well as the pathogenic anaerobes; therefore, we concluded that the organisms were carried in the intestinal tract of the larvae and we were unable to reach them with a sterilizing solution.

STUDIES ON BLOW FLY LARVAE

(Under Aseptic Conditions)

These flies were secured by exposing raw beef outdoors and when the flies had deposited a mass of eggs, the meat was transferred to a glass jar and the jar stopped with cotton wrapped in a fine grade of cheesecloth. The eggs hatched in eight to twenty-four hours, and the larvae were given

FIG. 5

Sterile food used in growing maggots for the patient's wound.

FIG. 6

Gooch crucible. Complete for washing the eggs.

FIG. 7

Gooch crucible showing perforations in the bottom.

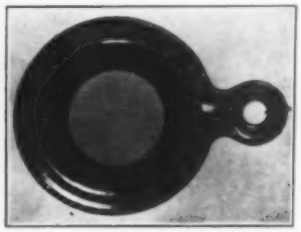

FIG. 8

Strainer used in washing maggots.

fresh beef each day for seven days. The larvae were now full-grown and the jar containing them was placed in a larger jar which contained about two inches of sand in the bottom. This sand had been baked in a hot-air oven one hour at 160 degrees centigrade. The stopper was removed from the jar containing the larvae and they immediately left their food and dropped into the jar containing the sand. In twenty-four to thirty-six hours all these larvae had pupated. The jar in which they had fed was removed and the jar containing the sand and pupae was covered with a piece of cheesecloth and an elastic band slipped over it. The pupal period of these larvae lasted from five to seven days when the adult flies emerged. The jar was now placed in a cage, twenty-four inches square, made of wire screening. Food was supplied at once and consisted of granulated sugar (sucrose) dissolved in water. The cage was kept in the laboratory. In two days all the flies were dead.

Several generations of flies were secured in the same manner but lived only a few days after hatching. We, therefore, concluded that the laboratory air did not contain enough moisture, the temperature was not constant, the food was, no doubt, insufficient, and there was a possibility of the flies being poisoned from the wire screening.

A large glass incubator was then constructed in which the temperature was controlled by a thermostat, the humidity controlled, artificial light

supplied, and circulation of the air carried on by a small motor. For housing the flies, small cages were built to fit inside the incubator; these cages consisted of a circular bottom made of light wood and a wire frame. A bag made of a fine grade of cheesecloth, fitted with a sleeve on one side was slipped over this, the sleeve being used when feeding or capturing the flies. Another generation of flies was secured as before and, when hatching began, the flies were placed in the gauze cages. Food for these flies consisted of strained honey, water, and yeast. Small pieces of raw beef were given to them to receive their eggs.

These flies lived, were very healthy, and when they were seven days old began laying eggs.

An attempt was made to free the outside of the egg from bacteria by chemical sterilization, believing the inside of the egg was free from bacteria.

A great many experiments were carried out, using various sterilizing solutions, such as bichlorid of mercury, strength one part in 1,000, phenol, alcohol, argyrol, mercurochrome, gentian violet, hexylresorcinol and silver nitrate. The experiments were carried out under various lengths of time and temperatures. Most of these experiments were very unsuccessful, due to the fact that either the egg embryo was killed or the bacteria survived.

With the bichlorid solution used at room temperature for one hour, we were able to destroy the bacterial flora, but most of the eggs were destroyed as well.

Some sterile larvae were obtained, however, and when hatched on sterile agar culture media no evidence of contamination could be found, but the agar culture media was not a satisfactory food for the larvae, and after crawling over and burrowing down into the agar they did not increase in size and lived only a few days. Various sterile synthetic foods were tried, such as dextrose agar, meat extract agar, sterilized cheese, liver extract media, and sterilized ground beef. All of these foods were unsatisfactory. A food was then made which consisted of nutrient agar, peptone, Fleischmann's yeast and liver, sterilized by autoclaving. This proved to be very successful and has been used throughout the entire work.

We carried out many experiments and used the larvae in the treatment of the wounds by sterilizing the eggs in bichlorid, strength one part in 1,000, plus one-half per cent. of hydrochloric acid, for one hour.

The sterile eggs were allowed to hatch and the larvae feed on the agar and liver food mentioned before. On this food the larvae reached full growth, pupated normally, and emerged as well developed sterile flies.

PRESENT TECHNIQUE

An incubator should be constructed in which the temperature is controlled by a thermostat and operated continuously between seventy-five and eighty degrees Fahrenheit, humidity controlled to fifty per cent., artificial illumination given with electric-light bulbs, and circulation of air supplied by a small motor.

FIG. 9

Cage for housing the flies. The side sleeve is used when feeding or catching the flies. When transferring the flies from one cage to another the top opening is untied and a clean cage is inverted over the old one. A light is placed over the top cage and the flies will at once fly into the clean cage. When they have all been captured the gauze can be drawn together and tied.

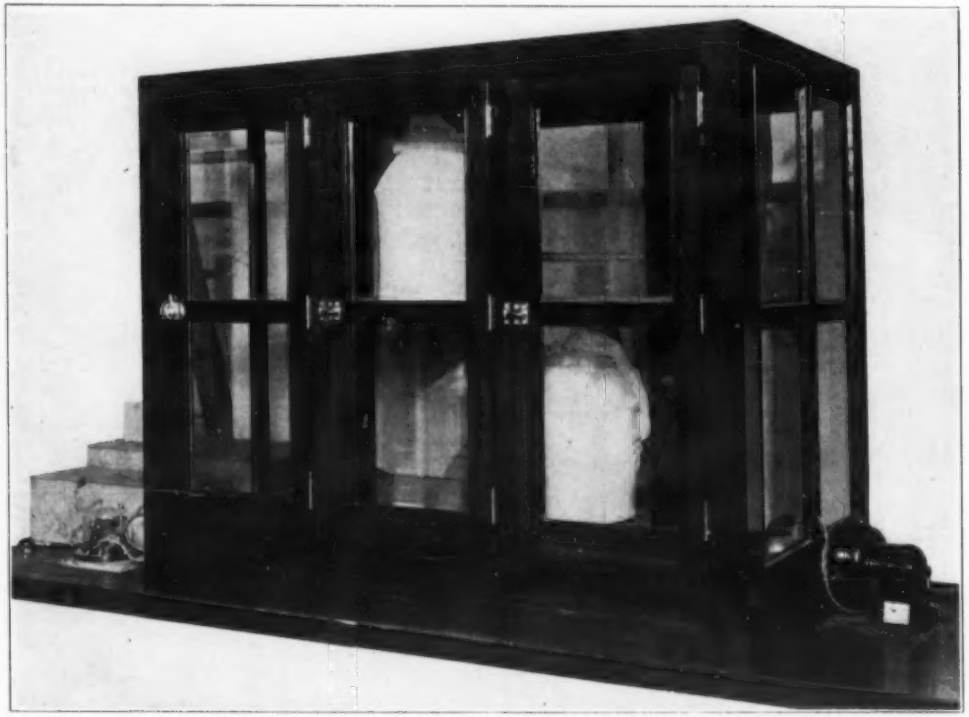

FIG. 10

Incubator used for housing the flies. On the right the blower can be seen and on the left two boxes. The large box contains water to supply moisture and the smaller one contains the heating coils. On the left also is the thermostat control. The thermostat can be seen on the inside of the incubator on the right-hand side.

For housing the flies, small cages should be built to fit inside the large incubator. A satisfactory cage consists of a circular bottom made of wood and a wire frame. A cheesecloth bag is slipped over this, one side being fitted with a sleeve which may be slipped over the arm when feeding or capturing the flies. Sunshine is very necessary for the flies, and the cages should be removed from the incubator and placed in the direct sun rays (not coming through window glass) at least once or twice each week.

TO CULTURE FLIES

A culture of flies may be started during the summer months by exposing raw beef outdoors, and the generation of flies carried through as already explained.

The desired species of flies can be identified and kept for egg-laying and breeding purposes. We have found the following species satisfactory for this work:—*Phormia Regina, Sucilia Sericata, Lucilia Ceaesar.*

LIFE HISTORY OF MAGGOTS

The fly, after being hatched, produces eggs in four to seven days. Eggs hatch in eight to twenty-four hours. Larvae turn into pupae in five to seven days. Adult flies emerge in seven to ten days.

In growing the larvae to carry on the generations of flies we use the following food:—

Ground raw beef, 1 part
Ground raw liver, 1 part
1 cake of Fleischmann's yeast to every 250 grams of the combined raw meat.

This mixture is placed in bottles of six inches in height by two inches in diameter to a depth of two inches. Plugs for the bottles are made of cotton wrapped with cheesecloth. All bottles and plugs before they are used are sterilized in hot air at 160 degrees, centigrade, for one hour.

This food is autoclaved for thirty-five minutes under fifteen pounds' pressure; allowed to cool and then incubated at thirty-seven degrees, centigrade, for thirty-six hours; autoclaved again for thirty-five minutes under fifteen pounds' pressure and stored on ice.

Larvae from sterilized eggs are placed on this food and the bottles kept in the fly incubator; the bottles should be wrapped in dark paper to protect the larvae from the light. If too many larvae are placed in the bottles they will leave their food before they are full grown, so care must be used at this point.

When the larvae have reached their full growth (which requires from five to seven days) place the jar in a larger jar containing about two inches of baked sand in the bottom. Remove the cotton plug and the larvae will pupate in the sand. Remove the feeding jar and place cheesecloth over the jar containing the sand and pupae. In seven to ten days the flies will

emerge. The jar is now placed in the gauze cage. (For perfect breeding twice the number of males to females should be kept in each cage.)

FOOD FOR FLIES

Food should be supplied at once, and consists of

Strained honey — 30 cubic centimeters
Fleischmann's yeast — 3 grams
Water — 70 cubic centimeters

Stir the mixture well and pour into small Petri dishes containing absorbent cotton in the bottom. Fresh dishes of food should be supplied each day. The flies must be given abundant food at all times.

After hatching, the flies require from five to seven days to develop before they will begin to lay eggs. When egg-laying begins, the flies are supplied with a small cube of fresh beef from which the outside surfaces have been cut off. We place the beef in the cages at nine o'clock in the morning. After about seven hours' exposure to the flies, the meat is taken out and the eggs are removed by gently washing them with water and freeing them from the meat with a small probe or knife. Then the eggs are placed in a small bottle containing sterile water. This is done to protect the eggs from drying out. The eggs are now placed in the ice-box kept at a temperature of forty degrees Fahrenheit; at this temperature the eggs will not hatch and they may be kept for twenty-four hours without injury.

STERILIZING THE EGGS

Test tubes, six inches in height by three-fourths inches in diameter, fitted with small wooden applicators, and plugged with cotton and sterilized in hot air at 160 degrees, centigrade, for one hour, are used as containers for sterilizing the eggs. The clumps of eggs are separated by vigorously stirring the water they are now in. After this is accomplished they are divided and placed in test tubes to a depth of one-half of an inch. The eggs will settle to the bottom of the tube and any supernatant water present can be poured off. The sterilizing solution is then poured on to the eggs. This solution is made as follows:

Stock solution of bichlorid of mercury, strength one in 1,000 parts.
Stock solution of fifty per cent. ethyl alcohol.
Take equal volume of each solution, mix, and add one-half of one per cent. chemically pure hydrochloric acid.
The final solution will contain bichlorid of mercury, strength one in 2,000 parts, twenty-five per cent. alcohol, and one-half of one per cent. hydrochloric acid.

The eggs should remain immersed in this solution for thirty minutes; they should be gently agitated several times during this period by stirring with the wooden applicator. The neck of the test tube is passed through a flame and allowed to cool. They are now ready to be washed.

A satisfactory container for use in washing the eggs consists of a Gooch crucible with a cover; a piece of gauze is placed over the perforated plate and the crucible is fitted into a bottle. This is sterilized in hot air at 160 degrees, centigrade, for one hour. The eggs are strained through the gauze and washed by pouring sterile distilled water over them. After washing, the cloth with the eggs is transferred, using aseptic technique, to a bottle containing sterile food and the bottle placed in an incubator at seventy degrees Fahrenheit, moisture being supplied by keeping open pans of water in the incubator.

PREPARING STERILE FOOD

Two-ounce, wide-mouth bottles, stopped with cotton wrapped in muslin, are used as containers for food; these are sterilized in hot air at 160 degrees, centigrade, for one hour. The food consists of agar culture media liquified, one liter; one cake of Fleischmann's yeast; one-half pound of pig liver. The liver is cut into small cubes, placed in a pan, and covered with water and boiled over the flame for twenty minutes. The yeast cake is added to liquified agar and stirred well. One cube of liver is placed in each bottle and allowed to rest on the bottom of the bottle and slant to the side. Now the agar and yeast mixture is poured into the bottle until the liver is covered, except for about one-quarter of an inch. The bottles containing the food are autoclaved thirty-five minutes at fifteen pounds' pressure; then allowed to cool. They are incubated at thirty-seven degrees, centigrade, for thirty-six hours; then autoclaved again for thirty-five minutes at fifteen pounds' pressure. This food may be stored in the ice-box and kept several weeks.

To culture the larvae:—The second day after the eggs have hatched, the cloth containing the unhatched eggs is removed with a sterile forcep and cultures are made by taking scrapings from the agar and one or two larvae. These are crushed and anaerobic and aerobic cultures made. On the third day, provided the cultures are negative, the sterile larvae are ready for use.

Example:—Eggs sterilized on Monday will be hatched Tuesday.
Cultures are taken Wednesday.
Larvae ready for use Thursday.

When needed, these larvae, still small, are suspended by pouring sterile water into the bottles and straining them through a sixty-mesh wire strainer. The larvae are collected with a sterile spoon and placed in sterile bottles stopped with cotton wrapped in muslin.

If desired, the larvae may be held for several days by placing the bottles of food containing them in the ice-box at a temperature of forty degrees, Fahrenheit. They will become very inactive at this temperature and cease to grow until again placed at a higher temperature.

THE METHOD OF TREATMENT OF WOUNDS

The skin is washed off with sterilized water (normal salt solution) simply to remove the grease and dirt from around the wound. No sterilization or chemical of any other nature is used on the part to be operated upon.

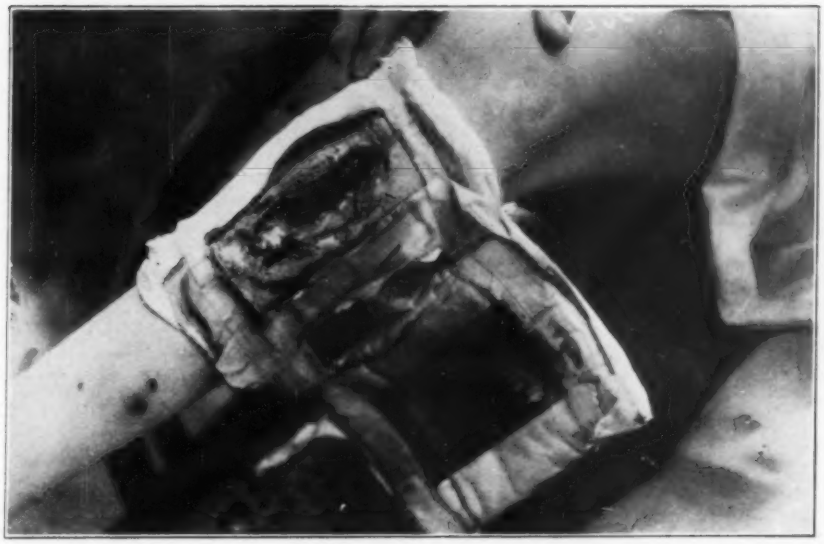

FIG. 11
Showing cage turned back.

FIG. 12
Showing maggots at work in wound.

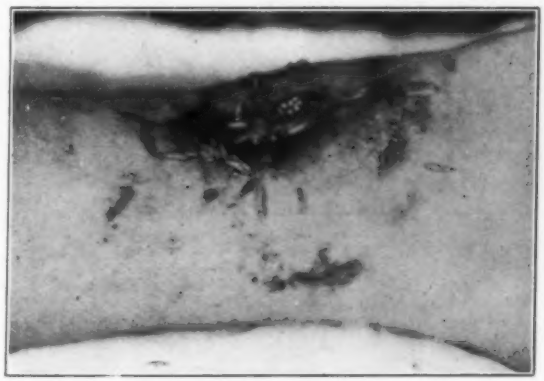

FIG. 13
Showing maggots at work in wound.

FIG. 14
Showing maggots at work in wound.

FIG. 15
Cured cases of osteomyelitis following maggot treatment.

FIG. 16
Another group of cases cured by the maggot treatment.

FIG. 17-A

Case 1. B. M. Before operation.

FIG. 17-B

Case 1. B. M. Before operation.

FIG. 18-A

Case 1. B. M. After operation.

FIG. 18-B

Case 1. B. M. After operation.

FIG. 19

Case 1. B. M. Almost healed.

FIG. 20

Case 1. B. M. Completely healed.

Iodin in any form, iodoform, bichlorid, mercurochrome, Scott's solution, or any of the chemical materials usually used in the preparation of the field of operation are absolutely tabooed. No gloves are used, so as to prove the point that it is the maggots, and the maggots alone, and not disinfection that does the work. One, therefore, lays bare the infected bone and cuts through the cortex and opens wide the medullary cavity. All granulation tissue and sequestra are completely removed. It is not always necessary to remove all cloaca for the maggots themselves seem to get around and through the cloaca. Therefore, a great deal of the structure of the bone may be saved rather than doing a complete saucerization of the wound. After the wound has been thoroughly cleaned in this manner, simply by débridement and without antiseptics, the wound is packed with plain sterile gauze. This is in order to check whatever hemorrhage may occur, and these packs are left in twenty-four to forty-eight hours, according to the amount of hemorrhage started up. At that time the pack is removed and the sterilized maggots are turned into the wound. The wound should be entirely filled with the maggots so that every part may be attacked by the maggots at the same time. It very often happens that a certain part of a wound offers more delicious food than any other part of the wound, and hence with only a few maggots they all seek the green pastures. Thus it is better to have so many maggots that the cleaning-up process which they carry on is universal throughout the entire wound. Before the maggots are turned in, however, the wound is bounded on its edges by adhesive plaster. This is done for two reasons. In the first place, it offers a firm and secure basis on which to place the cages which are put on to prohibit the maggots from getting out of the wound. In the second place, it protects the skin from the sensation of tickling which is very often caused by the maggots when they walk on the normal skin. This tickling may be, and generally is, the only disagreeable feature of the treatment, because it may irritate the patient constantly. Hence, if all skin areas within the cage are thoroughly covered by adhesive plaster, firmly covered with collodion, these elements of irritation are abolished. After the maggots have been introduced into the wound in a sterilized state, they are sluggish because of their recent bath. Maggots are generally sent out in sterilized bottles. In order to get the maggots out of the bottles a little sterilized water is poured into the bottle. The solution, with the maggots, is then poured into a sterile sieve. The water runs off and the sieve is turned upside down and the maggots, though wet, are precipitated into the

FIG. 21
Case 3. A. W. Before operation.

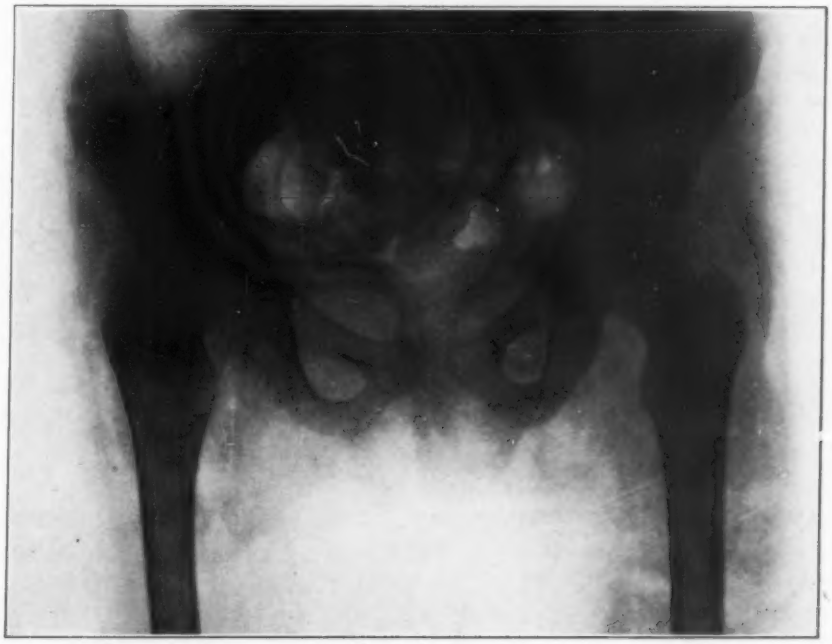

FIG. 22
Case 3. A. W. After operation. Tuberuclous hip.

FIG. 23
Case 3. A. W. During treatment. Tuberculous hip.

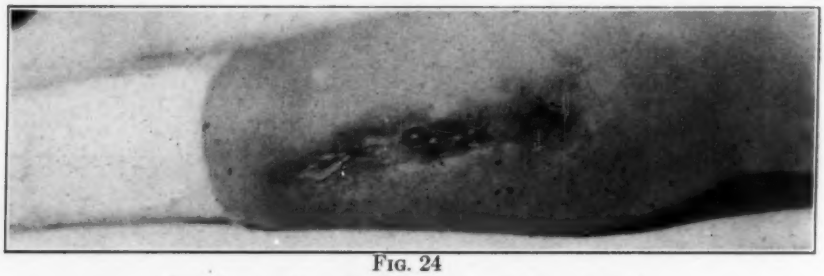

FIG. 24
Case 3. A. W. Almost healed. Tuberculous hip.

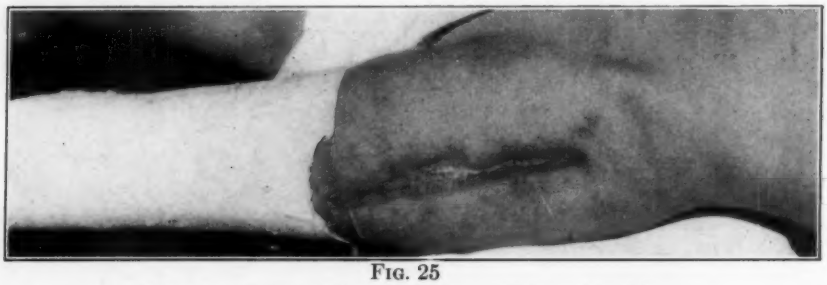

FIG. 25
Case 3. A. W. After treatment. Tuberculous hip.

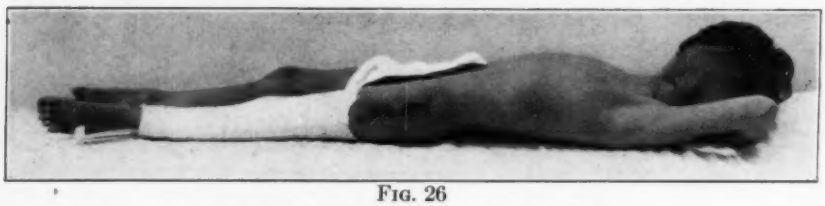

FIG. 26
Case 3. A. W. Healed tuberculous hip.

FIG. 27
Case 4. B. C. Before operation.

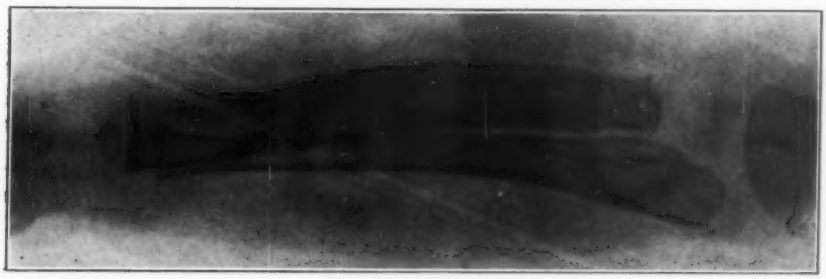

FIG. 28
Case 4. B. C. After operation.

FIG. 29
Case 4. B. C. During treatment.

FIG. 30
Case 4. B. C. Almost healed.

FIG. 31
Case 4. B. C. Healed.

wound. This sluggishness is quite acceptable as it allows a little more time for the placement of the cage over the wound. The cages, as seen in the pictures, are made of various sizes and shapes. The edges of the cage are made of soft sponge rubber, and over the top of this soft rubber is placed a very fine wire mesh which is sewn on to the rubber. These cages are cut to suit any size and contour of wound to be treated. Before being placed

FIG. 32
Case 15. F. R. Before operation.

FIG. 33
Case 15. F. R. During treatment.

FIG. 34
Case 15. F. R. During treatment.

FIG. 35
Case 15. F. R. Almost healed.

FIG. 36
Case 15. F. R. Healed osteomyelitis.

over the wound the bottom edge of the cage is covered with adhesive plaster, and the gum side exposed so that it attaches itself to the adhesive already placed around the periphery of the wound. This is strapped to the leg, or part involved, and by this means the maggots are retained within the wound itself. The top of the cage should be thoroughly exposed to the sunlight and air, and should not be covered up by gauze or other dressings which keep out sunlight and air. Both air and sunlight are necessary for the well-being and the activity of the maggots themselves. Maggots are like dogs—they seek the shade. The more sunlight, therefore, the deeper they penetrate into the cavernous aspects of the bone, and if one desires to send them more quickly into the lower depths one may use artificial light directly over the cage. By this means, also, the temperature of the maggot is kept more constant and it works better on account of the warmth and on account

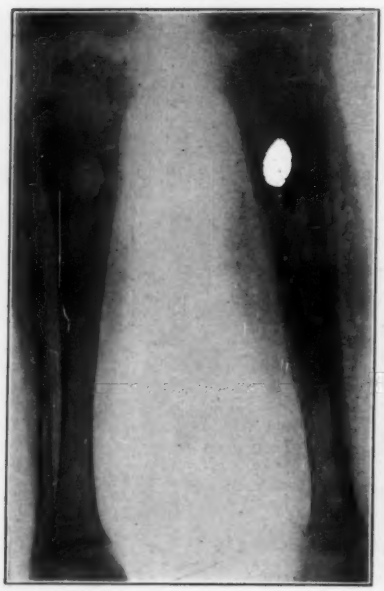

FIG. 37
Case 20. L. P. Before operation.

FIG. 38-A
Case 20. L. P. After operation.

FIG. 39
Case 20. L. P. During treatment.

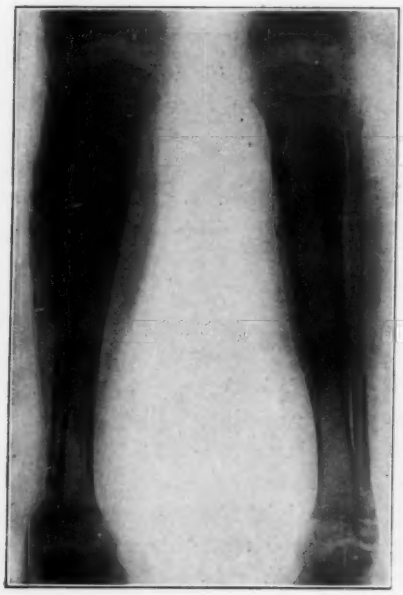

FIG. 38-B
Case 20. L. P. After operation.

FIG. 40
Case 20. L. P. Completely healed.

of the air. At the end of the fifth day the cage is removed, the adhesive plaster is removed, and the wound is thoroughly washed out with normal salt solution. All maggots that are in the wound are, therefore, washed away. One may use even little sterilized pledgets to take the membrane which is formed in the early stages of the process away from the depths of the wound.

After one application of maggots, indeed after the second or third day of the first application of the mag-

FIG. 41
Case 23. E. W. Before operation.

FIG. 42
Case 23. E. W. After operation.

FIG. 43
Case 23. E. W. Completely healed.

FIG. 44

Case 23. E. W. Showing method of treatment.

gots, all wounds become alkaline. Most wounds have an acid reaction—either weak or quite strong—but it takes hardly twenty-four hours before this reaction becomes alkaline after the introduction of the maggots. I mention this fact because I believe that the alkaline reaction has a great deal to do with the sterilization of the wound and the killing of the bacteria. This period of changing every fifth day is done for the following reasons: The life history of the maggot under normal conditions is seven days. The maggot is about forty-eight hours old when he is inserted into the wound. The first day is occupied with his hatching and in sterilization, and the second is utilized in studying the bacteria and to show that the cultures which are made after the sterilization are perfectly negative. The following four days, therefore, he works in the wound. He is washed out then on about his seventh day, at which time, if left, he would change into a pupa and hence be of no service in the process of healing.

Even at the early stage of the first dressing one notices the change in the character of the wound. There may have been a slight amount of odor during the first two days after the insertion of the maggots, when the bacteria have been stirred up by their activity and when they are eating and destroying the dead tissue which is there. But, at the end of the first dressing, whatever odor there may have been practically ceases, and now one notices the beautiful reddish granulation that is springing up throughout the wound. At the insertion of the maggots, therefore, for the second time, at the end of five days, this process of cleaning up and of the growth of new granulation tissue is seen to be going on. The wound still remains alkaline and is becoming more and more filled with granulation tissue. There may be a scum over the granulation tissue at this time but this scum is due mostly to the proteus bacillus, which seems to be the most persistent organism to remain in the wound. The wound now fills up from the bottom with the continuous application of maggots every five days, and in about six to seven weeks the wounds in children are usually healed. In adults a

little longer time is taken, particularly where the osteomyelitis has been of very long standing and where there has been a great eburnation of bone and dense scar-tissue formation. Generally, the wound fills up with granulation tissue which becomes flat with the end surface, and the epithelial cells gradually grow over this granulation tissue and the resulting wounds are usually found entirely flat so that no deep sulci are left on the affected part, as in our former treatment by drainage, and the contour of the wound more nearly resembles the original shape of the part.

As soon as the skin of the patient has entirely healed, one may allow the use of the part. Before that time the patient is, as a rule, at rest so as to prevent any traumatism or strain on account of use.

ACTION OF THE MAGGOT WITHIN THE WOUND

At first the maggot seems to act as a scavenger. He busily sucks up the bacteria and consumes the dead tissue. He passes these through his intestinal tract. Some bacteria are thus killed, while others pass through

FIG. 45

Case 25. R. Y. Healed osteomyelitis.

FIG. 46

Case 25. R. Y. Healed osteomyelitis.

the intestinal tract in a perfectly live state. These live bacteria may be the source of further contamination. The maggots of this type destroy only dead tissue or tissue which is pathological. They will work around and separate a small sequestrum or dead particles of bone which are still attached to normal bone, and seem to gnaw down through the bone until the bleeding area is arrived at. Until the bleeding area is reached the granulation tissue will not grow over and amalgamate or attach itself to the bone. One can see the process of scarification by the maggots by closely observing them at work in the wound. So voracious are they in their struggle for food that they will stand upright on their heads with their tails in the air, as puppies do to crowd around a basin of food where the basin is too small for the number of puppies. They apparently continue this process of sucking day and night and seem never to tire. Apparently the time for inactivity is only when they go into the pupal stage. They do not like too much secretion, although they make some secretion by their own activity in the wound, and in certain cases it is rather wise to draw off the supernatant juice which is formed in the wound by their activity, lest they drown. Personally, I believe that the scavenger reaction is not the only method by which they heal the wound. I am inclined to think that there is some biological reaction which is formed between the activity of the maggot and the fluids of the human body which plays an important part in the healing of the wound. Just what this biochemical substance is, has not yet been absolutely determined by investigations. When the wound reaches the state of almost healing, when the bacteria become less from day to day, there comes a time when maggots placed in the wound will be killed after a stay of a few hours. This, too, is another problem and one which necessitates more biochemical work.

BACTERIA IN THE WOUND

Whatever the bacteria of the original wound, be they aerobes or anaerobes, and generally they are the former, the amount of bacteria begins

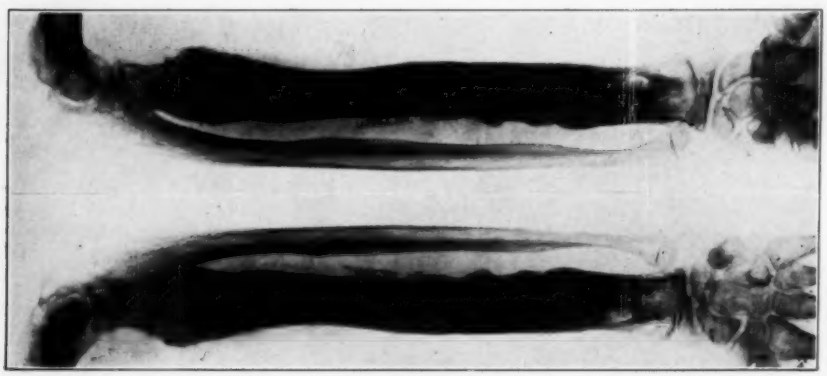

FIG. 47

Case 28. R. L. Before operation.

FIG. 48
Case 28. R. L. After operation.

FIG. 49
Case 28. R. L. Before treatment.

FIG. 50
Case 28. R. L. During treatment.

FIG. 51
Case 28. R. L. Nearly healed.

FIG. 52
Case 28. R. L. Healed.

to diminish from the first application of maggots. As I stated before, the wound becomes alkaline after twenty-four hours' activity on the part of the maggot, which can be easily tested out by litmus paper inserted into the wound. Daily the number of bacteria diminishes,—the streptococci and staphylococci seeming to be destroyed first and the proteus remaining until the end. There may still be, at the end, some few bacteria living on the surface but they are very few in number.

AGES

It is very much easier to heal up the wounds in children than in adults. Growing bone naturally aids the process of repair. The duration of time in children is about six weeks in the ordinary long bone. Of course, I am speaking again of chronic osteomyelitis. It is known that osteomyelitis in children generally occurs at the diaphyseal portion of the epiphysis, but the more I have studied osteomyelitis, the more I have been impressed by the fact that the point of rupture of the pus in the long bones—as the femur—is generally in the posterior part of the shaft near the epiphyseal line. And hence, often, I fear, the operation for acute osteomyelitis does not go down far enough to reach the point of infection. Later, then, one is confronted with a rupture of the pus on the deep surface of the bone, and I have seen such cases go directly into the joint by breaking through the periosteum on the posterior surface of the bone. Before doing a debriding operation on children one should be sure that the involucrum is perfectly well formed. In adults the question of healing is a more difficult one. The disease has often been present for years and years and the bone is extremely eburnated. Here also, the occurrence of the osteomyelitis in the shaft of the bone is more frequent than is the case in children, and yet the occurrence of infection of the diaphysis, next to the epiphyseal structures, is more apt to be the case than true diaphyseal osteomyelitis except in gun-shot wounds. Owing to a lack of growing cells, new bone formation is less active than in children and there is a greater quantity of old eburnated bone present to deal with, and the progress of healing is slower than in children. If the average child heals in approximately six weeks, the adult healing is at least a third longer; but, if the technique be carried out and the maggots allowed to remain until they are killed off by the nature of the secretion in the wound, healing will take place.

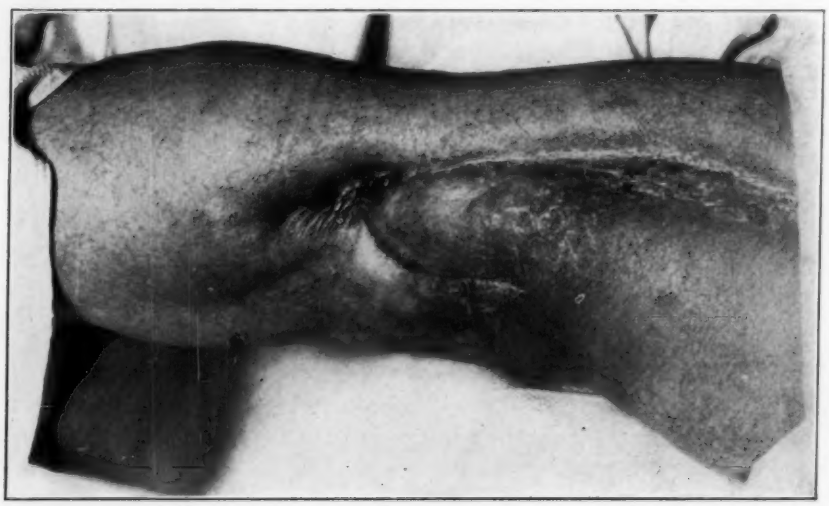

FIG. 53

Case 57. B. G. Nine years' duration. Seven previous operations. Seven operations. Healed.

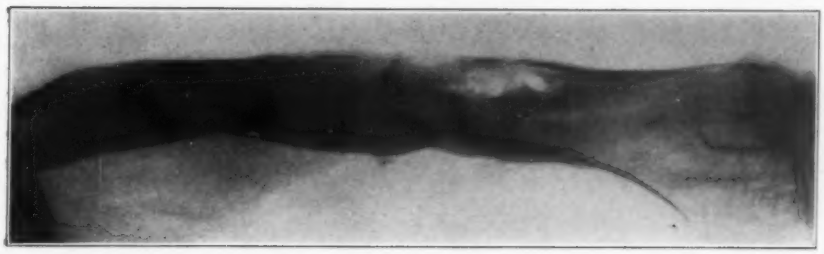

FIG. 54

Case 57. B. G. Three months after operation.

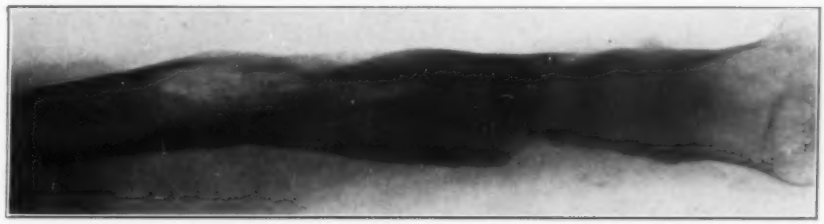

FIG. 55

Case 57. B. G. Three months after operation.

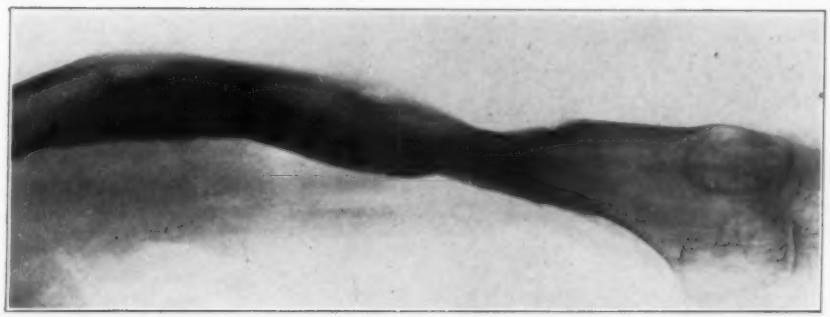

FIG. 56

Case 57. B. G. Ten months after operation. Nine years' duration. Seven previous operations. Seven operations. Healed.

RECURRENCE

There is a certain recurrence in about five per cent. of the children and five per cent. of the adult cases. Be they children or adults, this recurrence consists generally of small spicules of bone which work up to the surface and are extruded through a small sinus. Almost invariably they close up by themselves in a few days and need no further operative or maggot treatment. It is simply an effort on the part of nature to throw off some fragments of foreign material which in our stupidity we have overlooked. There have been comparatively few cases where a complete operation has had to be done over again where we have felt that we had done a complete operation the first time. In acute osteomyelitis, by treatment with the same method, we have shortened the time tremendously in the cure of the

SUMMARY OF CASE REPORTS

Case Number	*Diagnosis**	*Age*	*Onset Before Admission*	*Admission*	*Previous Operations*	*Operations*	*First Insertion of Maggots*	*Number of Insertions of Maggots*	*Healed*	*Duration*	*Infection*
Case 1, B. M.	Right tibia	4 years	3 months	Aug. 25, 1928	2	Sept. 18, 1928	Sept. 18, 1928	8?			
	Left tibia					Oct. 9, 1928	Oct. 11, 1928	Bacillus Welchii	Dec. 17, 1928	13 months	Staphylococcus
	Right tibia					May 14, 1929	May 16, 1929	6?	Aug. 27, 1929		
						Aug. 6, 1930	Aug. 9, 1930	7			
Case 2, T. M.	Left tibia	8 years	3 years	Nov. 29, 1929	2	Dec. 18, 1929	Dec. 24, 1929	6	June 1, 1930	6 months	Streptococcus
	Right tibia					July 23, 1930	July 25, 1930	24	Nov. 18, 1930	4 months	hemolyticus
Case 3, A. W.	Left femur	6 years	6 months	Mar. 14, 1929	0	Dec. 11, 1929	Jan. 9, 1930	5	June 1, 1930	6½ months	Tuberculosis and staphylococcus
Case 4, W. C.	Right radius	15 months	2½ months	Jan. 25, 1930	0	Feb. 12, 1930	Mar. 29, 1930	9			
						Feb. 26, 1930					
						Aug. 26, 1930	Aug. 28, 1930	4	Oct. 30, 1930	7 months	Staphylococcus
						Oct. 10, 1930					
Case 5, S. K.	Left humerus	11 years	2 years	July 11, 1930	2	July 16, 1930	July 18, 1930	16	Oct. 30, 1930	3 months, 11 days	Streptococcus pyocyaneus
Case 6, A. V.	Left femur	4 years	10 months	May 22, 1930	2	June 4, 1930	June 9, 1930	10	Dec. 20, 1930 Practically healed		Staphylococcus
						Nov. 12, 1930					
Case 7, M. S.	Left femur	10 years	4 years	July 7, 1930	3	July 9, 1930	July 12, 1930	19	Healed		Staphylococcus
Case 8, E. R.	Left femur	18 years	6 years	June 30, 1930	2	July 2, 1930	July 5, 1930	23	May 18, 1931		Staphylococcus
						Oct. 22, 1930	Oct. 25, 1930		Not healed		
				Feb. 22, 1931	4	Feb. 25, 1931	Feb. 28, 1931	5			
Case 9, M. D.	With multiple abscesses	11 years	1 year	Jan. 31, 1930	3	April 23, 1930	May 8, 1930	36	Improved, still under treatment		Staphylococcus
						Feb. 18, 1931	Feb. 21, 1931	3			
Case 10, N. T.	Right tibia	9 years	2 years	Oct. 23, 1930	1	Oct. 31, 1930	Nov. 4, 1930	3	May 18, 1931 Almost healed		
Case 11, P. B.	Right femur	14 years	1½ years	July 2, 1929	1	July 16, 1929	Nov. 21, 1929	5	Still under treatment		Staphylococcus
						Jan. 8, 1930	Jan. 11, 1930	3			
						June 4, 1930	June 16, 1930	23			
Case 12, J. I.	Right hip	11 years	1 year	Sept. 29, 1930	4	Oct. 15, 1930	Oct. 21, 1930	6	Improved, still under treatment		Negative Blood agar and broth
Case 13, S. Z.	Right tibia	13 years	5 months	May 22, 1930	1	May 28, 1930	May 31, 1930	31	May 18, 1931		Staphylococcus
						Feb. 18, 1931	Feb. 21, 1931	3	Almost healed		
Case 14, M. S.	Right femur	8 years	1 month	June 30, 1930	0	July 2, 1930	July 5, 1930	6	May 18, 1931		Staphylococcus
						Aug. 13, 1930	Aug. 16, 1930	1	Almost healed		Streptococcus
						Aug. 26, 1930					

*These are all cases of osteomyelitis unless otherwise stated.

Case Number	Diagnosis*	Age	Onset Before Admission	Admission	Previous Operations	Operations	First Insertion of Maggots	Number of Insertions of Maggots	Healed	Duration	Infection
Case 15, F. R.	With multiple abscesses	14 years	6 years	Nov. 4, 1929	2	Nov. 6, 1929 Mar. 27, 1930 Sept. 24, 1930	Nov. 8, 1930 Mar. 31, 1930 Sept. 29, 1930	2 12 10	May 18, 1931 Much improved		Staphylococcus
Case 16, E. MacM.	Right femur	4 years	4 years	Sept. 15, 1930	2	Sept. 17, 1930	Sept. 20, 1930	18	May 15, 1931 Healed		Staphylococcus
Case 17, E. S.	Right os calcis Left humerus	8 years	5 months 4 months	Nov. 4, 1929	5 4	Nov. 6, 1929 Mar. 21, 1930	Nov. 8, 1929 Mar. 31, 1930	6 2	Dec. 31, 1929 May 23, 1930		Staphylococcus Staphylococcus
Case 18, A. D.	Right humerus	3 years	7 months	July 2, 1929	7 3	July 9, 1929 Sept. 24, 1929	July 13, 1929 Sept. 30, 1929	11 8	Nov. 20, 1929		Staphylococcus
Case 19, W. C.	Right fibula	10 years	6 weeks	Aug. 29, 1929	2	Oct. 15, 1929	Nov. 19, 1929	6	Feb. 1, 1930	8 months	Staphylococcus
Case 20, L. P.	Both tibiae	3 years	8 months	July 12, 1929	2 on each leg	July 16, 1929	July 19, 1929	13 Left 13 Right	Nov. 20, 1929 Jan. 17, 1930	10 months 8 months	Staphylococcus
Case 21, A. L.	Right fibula	11 years	6½ months	Apr. 29, 1929	1	May 3, 1929	May 4, 1929	11	Sept. 29, 1929	1 year	Staphylococcus
Case 22, O. M. O.	Left tibia	8 years	1 month	Aug. 22, 1929	1	Sept. 13, 1929	Sept. 15, 1929	12	Nov. 8, 1929	10 months	Staphylococcus
Case 23, E. W.	Right tibia	14 years	4 months	Sept. 1, 1927	4	May 14, 1929	May 16, 1929	7	Aug. 27, 1929 Jan. 20, 1930	9 months	Staphylococcus
Case 24, H. S.	Left femur	10 years	6 years	May 10, 1930	5	May 21, 1930	May 26, 1930	7	July 22, 1930	2 months	Staphylococcus
Case 25, R. Y.	Right femur	11 years	3 years	June 26, 1928	3	Nov. 6, 1928	Nov. 11, 1928	1	Apr. 18, 1929	18 months	Staphylococcus
Case 26, R. P.	Right femur	6 years	6 months	Jan. 4, 1927	4	Sept. 18, 1928	Sept. 23, 1928	7	Nov. 23, 1928 Feb. 20, 1929	19 months	Staphylococcus
Case 27, M. M.	Right tibia	9 years	10 months	May 21, 1929 May 19, 1930	1	May 22, 1929 May 21, 1930	June 18, 1929 May 23, 1930	15 2?	Improved		Staphylococcus
Case 28, R. L.	Left radius	11 years	6 months	Feb. 24, 1930	1	Feb. 26, 1930	Mar. 4, 1930	9	May 23, 1930	4 months	Staphylococcus
Case 29, R. H.	Left tibia	4 years	1 year	Sept. 4, 1929	1	Sept. 6, 1929	Sept. 8, 1929	9	Dec. 15, 1929	9 months	Negative, Hemolyticus streptococcus, Staphylococcus aureus
Case 30, J. S.	Left tibia	14 years	1 year	July 8, 1929 Apr. 28, 1930	2 5	July 9, 1929 May 7, 1930	July 13, 1929 May 12, 1930	16 11	Sept. 24, 1929 July 12, 1930	2 months	Staphylococcus

*These are all cases of osteomyelitis unless otherwise stated.

Case Number	*Diagnosis**	*Age*	*Onset Before Admission*	*Admission*	*Previous Operations*	*Operations*	*First Insertion of Maggots*	*Number of Insertions of Maggots*	*Healed*	*Duration*	*Infection*
Case 31, F. K.	Right tibia	11 years	3 years	Oct. 22, 1929	0	Nov. 6, 1929	Nov. 9, 1929	4	Mar. 1, 1930	6½ months	Non-hemolyticus streptococcus, Staphylococcus
Case 32, R. N.	Left ankle, tuberculosis	45 years	2 years	July 1, 1930	1	July 2, 1930	July 4, 1930	12	Sept. 1, 1930	2 weeks	Negative
Case 33, M. B.	With multiple abscesses	13 years	5 months	Nov. 3, 1927	4	Nov. 29, 1927 Jan. 16, 1928 Nov. 20, 1928 Nov. 13, 1929 Apr. 2, 1930 July 16, 1930	 Nov. 17, 1930 Apr. 7, 1930 July 18, 1930	 15 20 16	May 18, 1931 Left humerus healed Tibia healed Two sinuses, left femur		Staphylococcus
Case 34, J. F.	Tuberculosis, right elbow	3 years	1 year	Feb. 20, 1929	0	Apr. 3, 1929 Dec. 18, 1929 Jan. 9, 1930 May 28, 1930	 Jan. 12, 1930 May 31, 1930	 3 3	 Sept. 2, 1930	1 year, 8 months	Tuberculosis
Case 35, D. Z.	Left femur	10 years	2 years	July 9, 1930	7	July 9, 1930	July 12, 1930	9	Aug. 28, 1930	2 months	Negative Blood agar and broth
Case 36, F. L.	Tuberculosis, left hip	8 years	5 years	Aug. 10, 1926	0	Aug. 12, 1926 Feb. 16, 1927 Apr. 2, 1930	 May 7, 1930	 11	 Healed		 Staphylococcus
Case 37, R. M.	Left ankle	15 years	3 weeks	Aug. 22, 1930	1	Aug. 26, 1930	Aug. 29, 1930	6	Healed		Staphylococcus
Case 38, H. Y.	Lower end right tibia	14 years	8 months	Nov. 14, 1930	0	Nov. 15, 1930	Nov. 19, 1930	12	Feb. 1, 1931		
Case 39, J. H.	Left tibia	12 years	2 years	Nov. 18, 1930	2	Nov. 26, 1930	Dec. 16, 1930	21	Jan. 15, 1931		
Case 40, C. B.	Right tibia	5 years	8 months	Dec. 5, 1930	1	Dec. 10, 1930	Dec. 16, 1930	7	May 18, 1931 Healed		
Case 41, J. N.	Left leg	11 years	2 years	Feb. 17, 1931	2	Feb. 20, 1931	Feb. 21, 1931	3			
Case 42, E. W.	Left leg	14 years	11 months	Dec. 2, 1930	2	Dec. 3, 1930	Dec. 17, 1930	20	May 18, 1931 Practically healed		
Case 43, F. N.	Right femur	7 years	5 months	Jan. 12, 1931	0	Jan. 21, 1931	Jan. 26, 1931	4	Healed		

*These are all cases of osteomyelitis unless otherwise stated.

Case Number	Diagnosis*	Age	Onset Before Admission	Admission	Previous Operations	Operations	First Insertion of Maggots	Number of Insertions of Maggots	Healed	Duration	Infection
Case 44, M. T.	Left tibia	18 months	1 year	Feb. 27, 1931	1	Mar. 4, 1931	Mar. 7, 1931				
Case 45, R. S.	Comminuted fracture, right femur	53 years	4 years	Mar. 19, 1929	1	May 20, 1929	July 20, 1929	11	Oct. 6, 1929 Healed		Staphylococcus
Case 46, L. H.	Right and left humerus Left femur	48 years	3 years	Dec. 26, 1929	13	Jan. 2, 1930	Jan. 6, 1930	17	Improved		
Case 47, L. R.	Tuberculosis, right ankle	29 years	1 year	Jan. 6, 1930	0	Jan. 13, 1930	Jan. 16, 1930	2	Jan. 25, 1930 Died, tetanus		
Case 48, B. B.	Compound fracture, left radius, ulna and left humerus	43 years	4 days	Feb. 22, 1930	0	Feb. 27, 1930	Mar. 4, 1930	6	Healed		Staphylococcus
Case 49, F. T.	Right tibia	9 years	6 months	Mar. 4, 1930	1	Mar. 6, 1930	Mar. 8, 1930	7	Sept. 29, 1930 Wound still slightly draining		Staphylococcus
Case 50, R. E.	Right tibia Amputation	38 years	1 year	Dec. 3, 1929	3	Dec. 5, 1929	Dec. 13, 1930	8	Jan. 25, 1930 Healed		
Case 51, A. M.	Old compound fracture, left tibia and fibula	53 years	2 years	Jan. 5, 1930		Jan. 6, 1930	Jan. 8, 1930		Feb. 24, 1930 Completely healed		
Case 52, P. H.	Right humerus	19 years	1 year	Jan. 7, 1930	1	Jan. 9, 1930	Jan. 11, 1930	3	Feb. 8, 1930 Improved		Staphylococcus
Case 53, B. M.	Right tibia	10 years	6 years	May 10, 1930	1	May 15, 1930	May 16, 1930	3	July 3, 1930 Improved		
Case 54, C. T.	With fracture of femur	40 years	23 years	Oct. 26, 1930	5	Nov. 6, 1930	Nov. 10, 1930		May 18, 1931 Much improved		
Case 55, K. T.	Left femur	20 years	9 years	Sept. 24, 1930	4	Oct. 4, 1930	Oct. 6, 1930	11	Apr. 15, 1931 Healed		Staphylococcus
Case 56, W. W.	Fracture of right tibia and fibula	33 years	5 months	Oct. 29, 1930	1	Nov. 3, 1930	Nov. 7, 1930		Nov. 14, 1930 Improved		
Case 57, B. G.	Left femur	39 years	9 years	Apr. 15, 1930	7	Apr. 18, 1930		29	Feb. 15, 1931		

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Case Number	*Diagnosis**	*Age*	*Onset Before Admission*	*Admission*	*Previous Operations*	*Operations*	*First Insertion of Maggots*	*Number of Insertions of Maggots*	*Healed*	*Duration*	*Infection*
Case 58, C. S.	Left humerus	24 years	7 years	Aug. 26, 1930	5	Aug. 28, 1930		15	Unimproved		
Case 59, A. N.	Right femur	22 years	16 years	May 29, 1930	Several	May 31, 1930		38	Oct. 27, 1930 Improved		
Case 60, F. R.	Left tibia	26 years	13 years	Feb. 17, 1930 Sept. 22, 1930	4	Feb. 18, 1930 Sept. 23, 1930			Unimproved Amputation		
Case 61, P. P.	Right femur Right tibia	24 years	12 years	May 7, 1930	6	May 9, 1930		26	Oct. 25, 1930 Tibia improved Femur unimproved		
Case 62, J. R.	Right tibia	16 years	7 years	May 12, 1930	3	May 13, 1930	May 17, 1930	9	July 18, 1930 Practically healed		
Case 63, J. U.	Right tibia	15 years	2 years	June 11, 1930	2	June 13, 1930		12	Sept. 3, 1930 Practically healed		
Case 64, E. G.	Left sacro-iliac articulation	27 years	11 years	July 2, 1930		July 10, 1930		9	Sept. 24, 1930 Healed		
Case 65, A. S.	Right tibia	30 years	6 years	July 24, 1930	5	July 26, 1930	Aug. 4, 1930	7	Improved		
Case 66, P. M.	Right femur	68 years	10 years	July 1, 1930	4	July 10, 1930		18	Unimproved		
Case 67, L. P.	Right second finger	33 years	5 months	Mar. 27, 1930	3	Mar. 28, 1930		3	Apr. 10, 1930 Unimproved		
Case 68, W. K.	Right femur	18 years	6 years	July 11, 1929	2	July 13, 1929	July 16, 1929	14	Improved		
Case 69, E. B.	Right femur Right ulna	21 years	4 years	May 8, 1930	1	May 13, 1930 Aug. 21, 1930 Oct. 28, 1930		28	Unimproved		
Case 70, R. R.	Left femur	35 years	10 years	Oct. 27, 1930	3	Oct. 28, 1930		12	Jan. 10, 1931 Improved		
Case 71, J. L.	Left femur	18 years	4 years	Sept. 23, 1930	4	Sept. 26, 1930		18	Mar. 10, 1931 Improved		
Case 72, J. O.	Left tibia	15 years	4 years	Oct. 1, 1930	9	Oct. 3, 1930		9	Improved		
Case 73, C. B.	Right tibia	17 years	2 months	Aug. 22, 1929	1	Aug. 23, 1929	Aug. 26, 1929	7	Aug. 1, 1930 Healed		

*These are all cases of osteomyelitis unless otherwise stated.

Case Number	Diagnosis*	Age	Onset Before Admission	Admission	Previous Operations	Operations	First Insertion of Maggots	Number of Insertions of Maggots	Healed	Duration	Infection
Case 74, H. S.	Acute Left tibia	16 years	Not known	Nov. 10, 1929	0	Oct. 12, 1929		2	Improved		
Case 75, J. P.	Tuberculosis, left foot	24 years	7 years	Oct. 2, 1929	0	Oct. 3, 1929		9	Unimproved		
Case 76, D. D.	Left tibia	35 years	11 years	Oct. 28, 1929	24	Oct. 29, 1929		16	Jan. 10, 1930 Improved		
Case 77, B. O.	Right tibia	24 years	3 years	June 28, 1929	1	June 30, 1929	Aug. 9, 1929	10	Aug. 11, 1929 Improved		
Case 78, H. B.	With compound fracture of right femur	17 years	6 weeks	Feb. 1, 1929	1	Feb. 4, 1929		16	Dec. 6, 1929 Improved		
Case 79, J. E.	Right tibia	5 years		Dec. 30, 1930		Dec. 31, 1930			Mar. 15, 1931 Almost healed		
Case 80, M. N.	Left femur	17 years	11 years	Sept. 9, 1929	2	Sept. 11, 1929		5	Nov. 23, 1929 Almost healed		
Case 81, J. W.	Acute, with compound fracture of left tibia	49 years		June 20, 1929		June 29, 1929		7	Feb. 20, 1930 Improved		
Case 82, T. B.	Left tibia	52 years	3 years	Nov. 18, 1930	3	Nov. 20, 1930		12	Mar. 18, 1931 Healed		
Case 83, A. C.	Multiple tuberculous osteitis with amyloidosis	14 years	2 years	Aug. 27, 1930		Aug. 29, 1930		12	Apr. 17, 1931 Unimproved		
Case 84, L. B.	Left femur	38 years	12 years	Nov. 14, 1930		Nov. 16, 1930		12	Feb. 14, 1931 Improved		
Case 85, V. McC.	Left fibula	22 years	12 years	Nov. 14, 1930		Nov. 16, 1930		12	Jan. 10, 1931 Improved		
Case 86, M. G.	Left tibia	15 years	2 years	June 12, 1930	1	June 14, 1930		10	Aug. 8, 1930 Almost healed		
Case 87, J. D.	Left femur	31 years	2 years	June 25, 1930	2	June 26, 1930		7	Jan. 1, 1931 Almost healed		
Case 88, C. B.	Left femur	48 years	2 years	Nov. 19, 1929	5	Nov. 20, 1929		6	Dec. 12, 1929 Improved		
Case 89, G. L.	Left femur	21 years	2 years	May 28, 1930		May 29, 1930		12	Aug. 24, 1930 Improved		

*These are all cases of osteomyelitis unless otherwise stated.

patient. In acute osteomyelitis, treated within the first few days from the beginning of the infection, one drills down to the spot where the osteomyelitis exists. The tension being relieved, the focus walls itself off or becomes circumscribed at that area. A slight drain is put into the drill hole so as to keep the skin from closing over. About the fifth day, after there has been an attempted walling off, the maggots are placed in the wound, which may have to be slightly enlarged to allow for their admission. These rapidly clean out the pus and separate whatever sequestra are going to be formed. The maggot has an intuition as to just where the line of demarcation is going to appear, and eats down to that line and thus removes all potential sequestra. The wound fills up rapidly by granulation tissue and is soon healed.

While one recognizes, in the treatment of acute osteomyelitis, that an immediate operation on the infected part, with a secondary operation for removal of sequestra, does often result in the cure of the patient, the time taken for this procedure is much longer than it is when maggots are used.

The time has been too short yet to make any definite assertions in regard to tuberculous lesions of bone or joints, or tuberculous abscesses. In cases of tuberculosis of the spine and tuberculosis of the hip, where abscesses have occurred, and where the abscess is purely tuberculous with a lining of tuberculous membrane, those abscesses may be opened with impunity, the tuberculous material evacuated, and maggots inserted according to the lines which have been previously laid down. The tuberculous abscess will heal, and stay healed, if proper conservative treatment is used at the same time for the treatment of the joint from which this abscess starts. We are in the habit of treating all mixed infections of the hip joint, which have a tuberculous origin and which have become secondarily infected, by means of maggots, and as yet we have not failed to clear up the secondary infection when the seat of trouble can be directly attacked. In cases of tuberculosis of the hip which have become secondarily infected, owing to the formation of an abscess, the following method is used: An incision is made along the crest of the ilium and down between the tensor femoris muscle and the sartorius (Smith-Petersen), and the hip joint laid widely open. Attempt is then made to remove the infected area, whether it be in the acetabular cavity or from the head of the femur itself. As much of the infected tissue as possible is removed by operative procedure. The maggots are then introduced into the hip joint in the same manner as already described. These wounds, with a few exceptions, have healed so far as their secondary infection is concerned. It is too early to state, however, just what the ultimate results will be, because one knows the tenacity with which tuberculous material hangs on to the human system.

CONCLUSIONS

1. Maggots have been found to be a tremendously useful adjunct to thorough surgical treatment of chronic osteomyelitis, and, in our opinion,

are far more successful in securing permanent healing of these extensive wounds than any other method tried by us.

2. Maggots, by their digestive action, clear away the minute fragments of bone and tissue sloughs caused by operative trauma in a way not accomplished by any other means. This is a tremendously valuable asset in the healing of a wound.

3. Maggots cause wounds to become alkaline and in this way diminish growth of pathogenic bacteria.

4. Maggots seem to have other more subtle biochemical effects within the wound itself and perhaps cause also a constitutional reaction inimical to bacterial growth. This is under investigation.

5. Maggots as raised and sterilized in the manner described may be used in any wound without risk to the patient.

6. The post-traumatic or postoperative general condition of the patient is better in maggot treatment than in the older forms of treatment where infection was combatted by chemicals or other types of dressing. There is less absorption and less toxic reaction.

7. In open tuberculous abscesses, with or without secondary infection, wide exposure followed by maggot treatment has proved surprisingly effective in a small number of cases and will be given further trial.

NOTE: It is evident that even in ancient times many surgeons had observed the effect of maggots on wounds, but it has remained for Dr. Baer to develop this idea in accordance with scientific medicine and surgery. The following article by Dr. Goldstein gives an interesting historical review of the subject of these observations referred to by Dr. Baer.—*Editor.*

MAGGOTS IN THE TREATMENT OF WOUND AND BONE INFECTIONS*

BY HYMAN I. GOLDSTEIN, M.D., CAMDEN, NEW JERSEY

A careful study of the works of Ambroise Paré[1] (1509–1590) and the translation by Theodore Johnson from the Latin discloses the fact that Paré was aware of the occurrence of live maggots in wounds and their beneficial effect. He states, in reference to bad skull wounds with bone infection: "But mark, after some months space, a great number of *worms* came forth by the holes of the rotten bones from underneath the putrefied skull; which moved me to hasten the separation and falling away of the putrid bones. . . . I observed three cavities of the largeness of one's thumb filled with *worms* about the bigness of a points tag. . . . The bone which nature separated was of the bigness of the palm of one's hand. The patient recovered beyond all men's expectation". And again he states: "And the corruption was such, that if any (wounds) chanced to be undrest for one day, ... the next day the wound would be full of *worms*".

Paré[1] speaking of the Battle of St. Quentin, 1557, says: "the wounds of the hurt people were greatly stincking, and full of *wormes* with gangrene and putrifaction".

D. Hieronymus Fabricius[2] states: "*Generantur inter dutem carnem, in auribus, in dentibus, putridis ulceribus, in thorace, renibus, utero, vesica, et vt. nonullis placet, etiam in iecore et cerebro; intestina tamen principem locum obtinent, de quo omnes consentiunt*".

Zachmann[3] (1704) makes an attempt to describe the origin of maggots in wounds rather than the effects on such injuries or wounds.

Baron D. J. Larrey[4] (1766–1842) says: "There is one more remarkable species of foreign bodies which we cannot pass over in silence, and which we have had an opportunity to notice with the majority of our wounded in Syria, during the expedition in Egypt. While the process of suppuration of their wounds was going on, the wounded were much annoyed by *the worms or larvae of the blue fly*, peculiar to that climate. These insects, hatched in a few hours, developed themselves with such rapidity that, from one day to the next, they grew to the size of a small goose-quill, which greatly terrified our soldiers, whatever we might say for their encouragement to the contrary notwithstanding. Nothing short of experience could convince them that these insects, so far from being injurious to their wounds, *promoted rather their cicatrization, by cutting short the process of nature*, and by causing the separation of the cellular eschars which they devoured. These larvae are, indeed, *greedy only after putrefying substances*,

*NOTE: The author of this article has given in detail a historical review of the opinions on this subject by several early observers who are mentioned in the previous article. This paper is particularly interesting in connection with the work of Dr. Baer who carried this idea to a practical conclusion. — *Editor.*

and never touch the parts which are endowed with life; under these circumstances also, we have never seen hemorrhage occur, whatever might have been the depth to which, according to the extent of the injury, these insects had found their way. Lotions of a strong decoction of garlic, of rue, or common sage, prepared at every time of dressing, were sufficient to cause their destruction; but soon after they were reproduced, owing to the insufficiency of the proper means to guard against the approach of the flies and to prevent the incubation of their eggs. But this may be readily accomplished by soaking the first compress of the dressing in a solution of camphor or any other antiseptic fluid."

Shafer (Camden) tells me he noted the clean healthy condition of leg ulcers that were infested with maggots, while an intern at the local hospital (1908–1909). This was also observed at Old Blockley, Philadelphia.

Crile, speaking before the Clinical Congress of Surgeons of North America ("War Session", October 23, 1917), said: "In the wounded who lie out in 'No Man's Land' for two or five or ten days, it has been found that the wounds that have done best are those that contain *maggots*. The reason for this is that there is devitalized tissue; the *maggots* live on this devitalized tissue, and if they destroy that tissue they do in time what the surgical operation does".

Dr. Edward Martin of Philadelphia, formerly Professor of Surgery of the University of Pennsylvania, said before the same session of the Clinical Congress of Surgeons of North America, that they had "been advised by one eminent member of the profession to take all the antiseptics and throw them into the sea, and another had advised them to raise a brood of *tame maggots to take care of the wounds*".

W. W. Keen of Philadelphia (1918), says: "During the Civil War *maggots* were very common in the summer .... the resulting *maggots* were certainly disgusting, but, so far as I ever observed, they did no harm. Crile (1917) now says that, on the contrary, they actually do good. This would probably be especially true in cases of infection from bacillus of gas gangrene."

The late William S. Baer[5] of Baltimore, Maryland, during 1929 and 1930 advocated the use of live maggots in the treatment of cases of osteomyelitis.

Whether this unique and ancient remedy ("viable antiseptic") will become popular in America remains to be seen.

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AMERICAN AND GERMAN ORTHOPAEDIC SURGERY

BY PROF. DR. FRITZ LANGE, MUNICH, GERMANY*

Director of the Orthopaedic Clinic in Munich

After reading the criticism of my book *Die Epidemische Kinderlähmung* (Epidemic Infantile Paralysis) in the January number of this *Journal* (XIII, 197, 1931), I realized that American and German orthopaedic methods differ in many respects. The friendly criticism of Dr. Leo Mayer states:—

> "Whether his method (namely, the silk-tendon plastic), demanding as it does, not only meticulous attention to every detail, but the enthusiasm born of conviction, will ever be accepted as generally in this country as the methods now current, seems to me doubtful."

This quotation shows that in the surgical treatment of paralytic deformities the views of American and German orthopaedic surgeons do not coincide; this is true also of other orthopaedic problems. In the belief that a study of both views should be made, I shall give the reasons why in the treatment of poliomyelitis we lay particular emphasis on the value of tendon transplantation. I hope that thereby my American colleagues will feel impelled to take issue on these questions to our mutual advantage, thus encouraging cooperation between the American and German orthopaedic surgeons.

In paralysis of the arms there is general unanimity of opinion. In a case of a paralyzed deltoid, if there are good muscles to transfer (either the trapezius or pectoralis major), I know that in both countries tendon transplantations are done. If there is insufficient muscle power, as is generally the case, an arthrodesis of the shoulder is performed.

At the elbow an arthrodesis at an angle of ninety degrees is not considered a good procedure in either country, and when possible active motion is striven for by transplanting the pectoralis major or the latissimus dorsi, or by shifting the origin of the flexors upward toward the shoulder joint (Steindler, von Baeyer).

In the hand, if there is a lack of active muscles to replace the paralyzed finger muscles, an arthrodesis of the wrist is done in order to secure material for tendon transplantation.

When scoliosis is present, due to a paralysis of the erector trunci muscles, in America correction by the Hibbs fusion operation is often attempted. In Germany we use only supporting braces and exercises. An operative method for overcoming paralysis of the abdominal muscles (though much to be desired) has, so far as I know, not been attempted.

*Translated by Dr. Nicholas Ransohoff and Dr. Leo Mayer, New York, N. Y.

The hip and knee can be considered together. In both countries arthrodeses were for a time frequently performed; now they are seldom done, since it has been shown that, in spite of operation, the patient will be obliged to wear a brace until the end of the growing period, in order to avoid contractures and deformities. The adult cripple, however, when asked if he wishes the knee or the hip stiffened, refuses because the arthrodesis makes it difficult to sit, which is the position which a severely paralyzed individual is compelled to assume most of the time.

At the hip, when the gluteals are paralyzed, we attempt—particularly in my clinic—to replace them by distant muscles,—either the latissimus dorsi, sacrospinalis, or vastus externus. Even if there is only a partial replacement of active flexion or extension, the gain for the patient is very great. He acquires control of his hip joint, the gait consequently becomes more certain and less fatiguing, and the endurance greater.

I do not doubt that these operations about the hip will find a welcome in America. The transplantation of long silk tendons into the back is simple and, when a surgeon has performed it once with a good result, he will tend to repeat it. My American colleagues may be encouraged to perform this operation by the assurance that no lengthy after-treatment with braces is required, and because neither by apparatus nor by any other type of operation can as good a result be secured.

Convincing proof of this is furnished by the case of a young American suffering from paralysis of the gluteals. In America he had been given non-operative treatment with every conceivable method, without improvement. Arthrodesis of the hip had been proposed by a number of orthopaedic surgeons, but was not accepted by either the patient or the father, a prominent professor of surgery. The patient was able to walk for

FIG. 1

Complete paralysis of the gluteus maximus of the right side. A sacrospinalis silk tendon plastic has been performed to replace the paralyzed muscle.

a—b indicates the line of the silk tendon. The picture has not been retouched.

only ten minutes at a time and was, therefore, unable to continue his profession, which required much walking and standing. This caused him both physical and mental suffering, and under these circumstances, it seemed to me that an attempt to replace the gluteals with the sacrospinalis was indicated. The result of this first gluteal plastic performed in 1921 surpassed all my expectations. One year after the operation, the patient had improved to such an extent that he was able to resume his profession; and as a result of the operation he has been made an active, happy individual. Letters from the patient nine years after the operation indicate that the result today is as good as immediately after the operation.

At the knee we are more conservative with tendon transplantation than twenty years ago, and employ this method only when there is a good prospect of enabling the patient to walk with movable knee joint. When the gluteus maximus is completely paralyzed, this prospect is slight; when, however, the gluteus maximus is strong, the prospect is good.

In the treatment of the joints so far discussed, there is obviously no marked point of difference between American and German orthopaedic surgery. With the foot, however, it is quite different,—here there is a marked divergence between the American and German point of view. In comparing the procedure of the two nations, it is quite clear that there is no unanimity among American orthopaedic surgeons, and the same is also true of the German orthopaedic surgeons. But the methods of the two countries show an essential difference. The American surgeon stresses the stabilization of the foot, and the German the restoration of muscle balance. I believe that the current American opinion has been expressed in MacAusland's excellent book on poliomyelitis which appeared in 1927 (Poliomyelitis: With Especial Reference to the Treatment. By W. Russell MacAusland, Philadelphia, Lea and Febiger, 1927). For him the standard operation from the eighth to the fifteenth year is Whitman's astragalectomy. From the fifteenth year he recommends arthrodesis by the methods of Hoke, Davis, and others. Tendon transplantations are also performed in America, either as separate procedures or together with an arthrodesis; but the small percentage in which tendon transplantation is performed alone is indicated by Henderson's summary from the Mayo Clinic; of 195 patients, sixty were treated by arthrodesis,—forty-six by arthrodesis and tendon transplantations, twenty-three by astragalectomy, and only eleven by tendon transplantation alone.

Also a commission appointed by the American Orthopaedic Association to determine whether arthrodesis or tendon transplantation was the preferable procedure, came to the conclusion:—"that tendon transplantation should be almost universally supplemented by stabilization of enough of the small joints of the foot to prevent or correct all tendency to varus or valgus deformity" (*Journal of Bone and Joint Surgery*, XI, 818, Oct. 1929).

In Germany it is believed that the reestablishment of muscle balance is all-important. I perform tendon transplantations on patients of five years and upwards with the attempt to restore the muscle balance of the foot so

thoroughly as to make future operations on the bones and joints unnecessary. It is only in patients who present themselves for treatment after the fourteenth year that we find arthrodesis necessary. But even in this group we are much more conservative in the use of arthrodesing procedures.

TREATMENT OF PARALYSIS OF FOOT FROM FIRST TO SIXTH YEAR

Until the sixth year the treatment of a child, who has had poliomyelitis in the second or third year of life, is probably the same everywhere. One tries to hasten the recovery of the affected muscles through the application of heat, exercises, etc., and takes measures, by means of apparatus, to prevent the tendency to contracture.

TREATMENT FROM SIXTH TO FOURTEENTH YEAR

In Germany—or to assume complete responsibility for the following, we should say in Munich—the abnormal position of the foot is corrected by redressment and the imperfect muscle balance restored by means of tendon transplantations; by this means a recurrence of the deformity should be prevented. The exact procedure for each type of paralysis is described in my book, *Die Epidemische Kinderlähmung.* Restoration of muscle balance can be attained only when it is possible to attach the muscles so that they will have an effect comparable to that seen in the normal foot. If one transplants the tibialis anticus to the cuboid in a case of paralytic club-foot, the result may be good so far as overcoming the club-foot deformity is concerned, but the muscle balance has not been restored and, if the foot is pliable, and the transplanted tibialis anticus functions well, the original pes varus will be transformed into pes valgus. The gait may be improved, in comparison with the original condition, but a perfect result has not been secured.

When, after a tendon transplantation, the wounds are completely healed and a six weeks' treatment in plaster-of-Paris has been completed, the patient is fitted with braces, which have a firm grip on the os calcis, and dorsiflexion and plantar-flexion are permitted very gradually by filing down the joint-stop millimeter by millimeter. The valgus and varus position is tested accurately and the apparatus is adjusted exactly according to the needs of the individual case. With this apparatus the patient is discharged from the clinic about ten weeks after the operation. The apparatus should prevent the stretching of the transplanted muscles, should preserve the normal mid-position between valgus and varus, and should promote the contraction of the stretched ligaments. Whoever fails to carry through this careful postoperative treatment with apparatus, will not be satisfied with the operation and will not consider it dependable.

What tendon transplants can accomplish is best shown with pes valgus; in this condition there is danger of an overcorrection by the method we employ. As soon as this tendency to overcorrection is noted, the braces

must be tilted into a valgus position and if this is not done in time, a planovalgus foot may easily be converted into pes varus, the correction of which can only be accomplished under anaesthesia. Better evidence of the effect of a tendon transplantation could scarcely be presented. I have tried more than most surgeons to determine accurately the limitations of tendon transplantations—one might, therefore, justly consider me as a partisan. On the basis, however, of thirty-five years' experience, I can state with certainty that by means of tendon transplantations the form and function of the foot may be rendered almost normal, even though there are not more than five of the nine muscles present. In some cases, even three muscles suffice. The ability to walk can be rendered normal; under all circumstances this procedure gives, in my opinion, the best results of any form of operative treatment.

One disadvantage of my operative method is the unpleasant necessity of wearing a brace for one or two years. In Germany, thanks to the organization of the Care of Cripples by the state, it is possible to carry out the details of brace treatment even for the poorest patient. A trained nurse is assigned to every district of 20,000 inhabitants whose duty it is to care for the infants, the tuberculous, and the crippled children. When the hospital treatment has been completed, she supervises the brace treatment and exercises at home, and when additional hospital care is necessary, arranges for the readmission to the clinic. This organization has, in its essentials, been developed in Germany during the past twelve years, at a time when this country's economic condition was at a low ebb. Despite this condition, the state authorized large expenditures for the crippled, realizing that any form of treatment which rendered the crippled self-supporting, saved the large outlay for cripple pensions.

Thanks to this organization in Germany, orthopaedic surgeons seldom lose track of their patients, are able to carry on a form of treatment which demands systematic reexaminations of the patients for many years, and are not forced to stress rapidity as an important factor in the treatment. If I am correctly informed, there are many states in America which lack such a type of organization. Private charity in America can collect much larger sums of money than is possible in Germany, but perhaps it is less efficient in the follow-up of patients than our governmental organization.

The essential aim of the American orthopaedic surgeons does not seem to be the reestablishment of muscle balance, but the stabilization of the foot and Whitman's astragalectomy appears to be the operation of choice for children of eight to fifteen years. This is unquestionably a brilliant operation, which permits easy correction of every foot deformity, favors normal heel and toe gait, by bringing the body weight more nearly over the center of the foot, and gives excellent stability without completely eliminating dorsal and plantar flexion. But despite this, the results of this operation cannot have been universally satisfactory in thousands of cases where it was used. The American surgeon, Straub, summarizes his opinion of astragalectomy: "Astragalectomy has always appeared to me to be a

mutilating operation at best, resulting in a definite amount of shortening of the extremity and a disfigurement of the foot, — in other words, a poor cosmetic result." (Surgery, Gynecology and Obstetrics, XLIV, 676, May 1927.)

Those cases which have come under my observation and which have been operated on by excellent American orthopaedic surgeons, and therefore represent unquestioned results, confirm the opinion of Straub. Unquestionably the Whitman operation gives a well stabilized foot in a short space of time (about six months). In comparison with a dangle foot, which may previously have existed, this represents marked improvement, but it differs radically in form and function from the normal foot, and therefore cannot be satisfactory to the exacting demands of patients in better circles of society. It is particularly in the case of calcaneus deformity, for which Whitman originally recommended this operation, that the functional result of a tendon transplantation is immeasureably superior. The paralyzed gastrocnemius can be replaced to a surprising degree by transplants of the peroneals, tibialis posticus, and flexor hallucis and flexor digitorum. In Figure 2 is pictured a patient with complete paralysis of the gastrocnemius, operated on by the author in 1910 at the age of six and one-half years. The tibialis posticus and peroneals were transplanted to replace the paralyzed Achilles tendon. Figure 3 shows the result ten years later. The foot shows normal form and function. Such a result cannot be secured by astragalectomy. Many a patient with complete paralysis of the gastrocnemius is enabled by tendon transplantation to balance on the toes of the operated foot. (Such is shown in *Die Epidemische Kinderlähmung*, page 157.)

FIG. 2

Severe calcaneus deformity resulting from complete paralysis of the gastrocnemius. Before operation.

FIG. 3

The same foot ten years after replacement of the gastrocnemius by the peroneals and the tibialis posticus. The photograph illustrates the range of active motion.

I have found nothing in the literature in regard to the usefulness of the astragalectomized foot in later years. MacAusland writes that in patients over fifteen years of age sensitive joints and pain may follow the astragalectomy. It seems to me possible that in those operated on between the eighth and fifteenth years, pain may develop during the third, fourth, and fifth decades, for the development of an arthritis deformans would seem almost certain with the marked incongruence of the joint surfaces produced by the Whitman operation. Therefore, one must consider most carefully whether the Whitman operation can satisfy the demands of the patients in later life. The employment of the Whitman operation in thousands of cases in America can be explained only by the fact that American surgeons were not satisfied with the results of tendon transplantations, which indicates a discrepancy between the American and German experiences. To explain this, one must determine how the American method of tendon transplantation differs from the German. The operative plan is markedly different. We take the greatest care to restore muscle balance and attach the muscles, when several important ones are paralyzed, to five or three typical points (*Die Epidemische Kinderlähmung*, page 104) and to carry out this operative procedure, it is frequently necessary to extend the transplanted muscles by means of silk tendons. This implantation of silk tendons is still generally considered an unreliable procedure, but this opinion is quite incorrect, and if the details of the technique are followed, which have been developed in more than 1,000 cases, the results will be exactly as good as claimed.

I do not hesitate to employ antagonistic muscles even though Dunn and others warn against this, and in my book are reproduced a large number of pictures which illustrate, for example, how the peroneus replaces the tibialis anticus and the hamstring muscles the quadriceps. The adaptability of the transplanted muscles has been underrated. In cases in which a right gluteus medius and minimus have been replaced by the middle one-third of the left latissimus dorsi, this portion of the latissimus dorsi can be made to contract independently, causing an abduction of the leg, whereas normally the entire muscle contracts to produce adduction of the left arm.

Many results of tendon transplantation are interfered with by adhesions to the bone, but these may be prevented by the insertion of paper and by means of properly planned skin incisions.

Finally, many well executed tendon transplantations are unsuccessful because of improper after-treatment, as above indicated. If attention is given to all the details, results of manipulation and tendon transplantation will be satisfactory in children of eight to fourteen years if five strong muscles are present. It is possible to reestablish a foot, normal in form and function, even if only three muscles are present.

Even with one strong muscle, the gastrocnemius, the muscle balance may be restored. Two silk tendons are run from the gastrocnemius to the fore part of the calf, attaching one to the scaphoid and the other to the

cuboid. If the gastrocnemius contracts, the foot is held in a position of 100 to 110 degrees, as in a well executed arthrodesis. If the muscle relaxes, the foot is able to adapt itself to the irregularities of the ground. If heavy demands are to be made of the foot, whose only muscle is the gastrocnemius, it is better to fix it by muscle transplantation than by arthrodesis. This is proved by the following case history:

In a twelve-year-old girl whose only foot muscle was the gastrocnemius, an equinus deformity had developed, which greatly interfered with walking and standing and caused a marked limp; a tenotomy of her Achilles tendon had been performed at another clinic, but with an unsatisfactory result. In 1922, I performed a gastrocnemius plastic, with two silk tendons, which enabled the patient to walk four or five hours with assurance and ease. Moreover, she developed into the best high-jumper of her class; she was able to jump one and twenty-hundredths meters. Naturally, she took off with the good foot, but that she was able to put her weight on the paralyzed foot at the end of the jump, and that it did not deviate into valgus or varus, was unquestionably due to the tendon transplantation. I have never seen such a result in an arthrodesed foot, and consider it quite improbable that this could be accomplished by a foot made rigid by bony stiffening. The same view is held by those patients who have had an arthrodesis of one foot and a tendon transplantation on the other and are, therefore, able to compare the results of the two operations by their personal experience.

It is only in exceptional cases that I have performed bone and joint operations before the fourteenth year. If there is marked equinus and the remaining muscles are weak, I limit the motion in the upper ankle joint by means of Spitzy's partial arthrodesis, or by my connective-tissue arthrodesis. In both operations, described in greater detail in my book, the cartilage is not entirely removed. The aim of the procedure is to reduce the ankle motion to about ten degrees.

When one compares the results of the American astragalectomy with those of the German tendon transplantation, I believe that the following generalization may be made: the astragalectomy is an excellent operation for patients between the ages of eight and fourteen years when it is desirable to obtain a stable foot quickly and with minimum expense, making the use of a brace unnecessary. This type of foot may be quite satisfactory to a patient whose work is chiefly standing or sitting, who consequently is obliged to walk but little, and who does not stress the appearance of the foot. If, however, the patient demands a foot which as nearly as possible resembles the normal, in form and function, he will not be satisfied with an astragalectomy. This applies particularly to individuals who wish to participate in social life. With a stiff foot, one is unable to dance or to play tennis, and, above all, is greatly hindered in mountain climbing. This last fact is of great importance to the Germans, the majority of whom take their vacations in the mountains. Any form of treatment which makes this impossible would be refused by our cripples and by their parents,

and for this reason the astragalectomy has never gained a foothold in Germany. On the other hand, it is regarded as most desirable that a patient be enabled to dance, play tennis, and climb mountains in spite of a severe paralysis. We, therefore, always note in the history of a patient the effect of the operation on his ability to walk. Also, from a psychological standpoint, it is of the greatest benefit to the paralyzed patient to be able to participate in the social activities of his companions. This can be accomplished only by a tendon transplantation, not by an astragalectomy. Therefore, it is my opinion that in all lands one should, in the case of children of five to fourteen years, attempt to restore as far as possible the normal form and function of the foot by tendon transplantations.

THE TREATMENT AFTER THE FOURTEENTH YEAR

The arguments against arthrodesing operations (the Whitman astragalectomy excepted) in the younger children, which have been presented both by Americans and Germans, lose force with the fifteenth year when ossification is almost completed and from this time on the operative treatment shows essential difference. In America, instead of the Whitman astragalectomy, methods have been developed which seek to maintain limited motion in the upper ankle joint, arthrodesing the lower ankle joint, the astragaloscaphoid and the calcaneocuboid joints.

These operations have been developed by Davis, Hoke, Ryerson, MacAusland, Albee, Steindler, Jones, Dunn, Putti, and Campbell. Apparently they are used in much the same way, with feet completely paralyzed, and with those having some muscles still present. Some authors perform tendon transplantations in addition to the arthrodesis, shifting the active muscles to the dorsal or plantar surface of the foot, according to the type of paralysis.

Some American orthopaedic surgeons perform these arthrodesing operations before the fourteenth year, but MacAusland, who reexamined a series of children operated on during the early years of life, found that the result of arthrodesis was not satisfactory. The best results were found in children operated on in the sixteenth year. I assume that most American orthopaedic surgeons hold the same view.

In American articles I have found, unfortunately, very few histories with good illustrations which permit me to reach a definite opinion of the results. I assume that the operations referred to, in contrast to the Whitman operation, do not seriously alter the form of the foot, that they secure good stabilization of the joints of the posterior half of the foot, but I have found nothing to give an indication of the function of the foot with particular reference to such severe tests as mountain climbing.

In Germany, as in America, after the fifteenth year, severe deformity is corrected by means of bone operations. At this age there is little prospect that dangle joints can be stabilized and deformed bones reshaped by redressment. We have, however, no universally accepted operation which

is used for every type of deformity, but we treat each individual case by an appropriate method. When there is marked abduction of the forefoot, we remove a wedge from the neck of the astragalus and then correct the abduction deformity. Conversely, in a case of pes adductus, correction is secured by removal of wedge from the cuboid and, if necessary, from the os calcis. In pes varus, we remove a wedge from the lateral half of the subastragaloid joint; in pes valgus, from the medial half.

The joints between the astragalus and the scaphoid and between the os calcis and the cuboid we arthrodese rarely, since the arthrodesis of these joints renders the gait non-elastic and hinders the push-off at the end of the stride. We are also less prone to use the Campbell operation which has evidently become popular in America during the past years, particularly in those cases which have suitable muscles for transplantation to the dorsum of the foot. For, if the plantar-flexion is blocked at 100 or 110 degrees by a bony spur, the usefulness of the foot is bound to be considerably lessened in dancing, or in mountain climbing. Nor do we perform an arthrodesis of the subastragaloid joint in every case. If five powerful muscles are present, we try to preserve supination and pronation, for the gait is more pleasing to the eye, and there is a greater degree of security of a foot that can actively pronate and supinate. Also, in patients who have developed poliomyelitis after the fifteenth year, and whose feet still show approximately a normal form, we consider it possible to avoid arthrodesing the subastragaloid joint.

If, however, a marked grade of varus or valgus is present, or if the

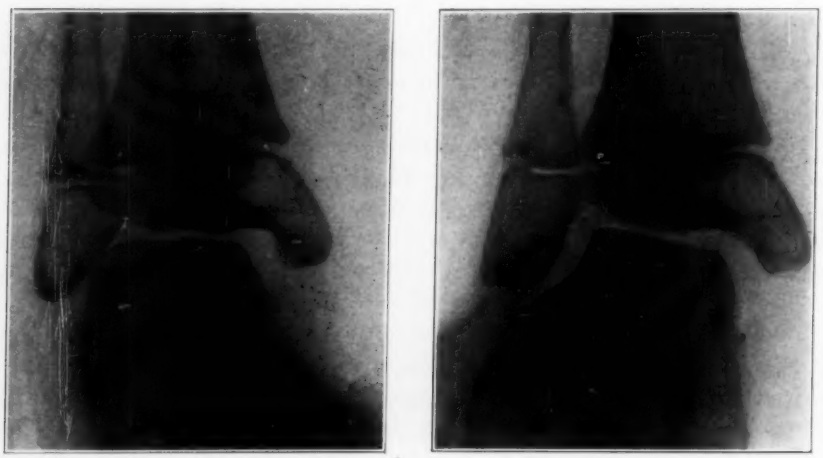


FIG. 4-A FIG. 4-B

FIG. 4

Roentgenograms of the ankle of a ten-year-old girl with paralytic club-foot.

Fig. 4-A. Indicates the position of the astragalus when the foot is adducted.
Fig. 4-B. Shows the foot abducted. Note the shift in the position of the astragalus.

active muscles are insufficient to permit of more than plantar and dorsal flexion, then, as in America, we arthrodese the subastragaloid joint.

Before performing an arthrodesis, we determine carefully the joints which are insecure as has been described in my book (*Die Epidemische Kinderlähmung*). In cases showing instability with reference to varus and valgus, the main difficulty is not so much in the subastragaloid joint as in the astragaloscaphoid joint. An example is shown in Figure 4. In this type I do not arthrodese the subastragaloid joint, but attack the seat of the trouble: namely, the astragaloscaphoid joint. When there is a relaxation of the astragaloscaphoid and calcaneocuboid joints, I do not as a rule perform an arthrodesis, but prefer a tenodesis, constructing artificial check ligaments of silk to correct the equinus deformity of the forefoot. The push-off of the foot after this operation is easier and more elastic than after the arthrodesis of the above named joints.

Despite such minor differences there exists no essential disagreement between the American and German schools in the treatment of cases over fifteen years of age, with some of the muscles still active. Also in the treatment of completely paralyzed feet, there is no essential disagreement. The number of joints which the German orthopaedic surgeon arthrodeses is perhaps not as large as in America, but we agree in the main principle: namely, to preserve some motion in the upper ankle joint, and to arthrodese the subastragaloid joint if it is possible.

SUMMARY

In the treatment of paralyses of the arm and the knee, there is no essential difference between the American and the German orthopaedic schools. In paralyses of the hip, the Germans stress the transplantation of muscles to replace the paralyzed ones, since the patients by this means regain control of the hip joint and learn to walk with more stability and for a greater distance. In America, apparently few operations of this type have been performed. For the paralyses of the foot there are, however, very marked differences of opinion.

From the eighth to the fourteenth years, I avoid bone and joint operations with the exception of Putti's partial arthrodesis and my own connective-tissue arthrodesis of the upper ankle joint, but correct the deformity of the foot by thorough manipulation and then take great pains to reestablish muscle balance by means of tendon transplantation. Such a plan of treatment can be successful only after careful treatment with apparatus carried out for one or two years.

Our method seems to have three advantages over the astragalectomy:

1. The foot is not deformed by the operation, but maintains its normal structure.
2. Redressment and tendon transplantations are less dangerous procedures than astragalectomy. Bone and joint operations are sel-

dom necessary up to the fifteenth year in patients who have been treated by my method.

3. The most important motion of the normal foot is retained; therefore this type of foot is far superior to the stiff foot when tested by demands of social life such as dancing, tennis, and mountain climbing.

If one reckons the usefulness of the normal foot at 100 per cent., then one is able to secure by redressment and tendon transplantations, sixty to eighty per cent. of normal. The usefulness of a foot after astragalectomy I should rate, with reference to demands of social life, at thirty to forty per cent. If it is possible, therefore, to carry out the necessary after-treatment with apparatus, one ought to favor the German method. Only when for economic reasons the after-treatment cannot be effectively carried out, is astragalectomy indicated, because it is the most rapid and economical method of stabilizing the foot.

From the fifteenth year on, operations on the bones and joints are indicated in cases of severe paralyses to correct the deformity of the foot and to stabilize relaxed joints.

If the patient stresses the importance of having a foot which is capable of responding to the demands of social life, then one should try to preserve active supination and pronation, provided five powerful muscles can be utilized for transplantation. In all severe paralyses, one should combine the arthrodesing of the subastragaloid joint with tendon transplantation, a combination which was first developed in systematic fashion by American orthopaedic surgeons. In Germany, this American method has been adopted, and I do not question that it will be used more and more frequently in patients of fifteen years of age.

If American orthopaedic surgeons were to limit as far as possible the astragalectomy in children under fourteen years of age, and stress the importance of tendon transplantations, unanimity could be reached in the surgery of paralytic deformities and the number of paralyzed feet which could meet the demands not only of daily labor but of social life would be much greater than at present.

THE BREAKING STRENGTH OF HEALING FRACTURES*

BY MERRILL K. LINDSAY, M.D., AND EDWARD L. HOWES, M.D.
NEW HAVEN, CONNECTICUT

The material submitted in the following pages represents the result of observations made during the past three years in an effort to establish a base line showing the normal or average rate of the healing process in fractures, based on a determination of the breaking strength. The question of breaking strength and a proper definition of the term was given careful consideration. It was realized at the onset that the interpretations given the results of a series of tests may be widely influenced by the working principle adopted for the tests and the details of the laboratory technique employed in carrying them out. For this reason, Mr. George W. Colton, of the Materials Testing Laboratory of Yale University, was consulted and it was decided to employ a beam, or transverse test, rather than a column test. The transverse test permits a considerable simplification in laboratory procedure and so, for this and other reasons, it was considered preferable to the column test.

In this test the bone rests without constraint on two supports set at a fixed distance apart. This distance will be referred to as the span, in that which follows. The bone is then loaded transversely, like a beam, the load being applied in two equal parts at two points adjacent to the point of fracture. By breaking strength, we mean the load in grams necessary to break the bone when loaded and supported in the manner described above.

The conditions chosen to be used as constant factors in the experiment were selected as representing as nearly as possible average conditions and no attempt is made in this paper to interpret the effect of any individual factor.

In order to evaluate the results of the observations on breaking strength, the structure and regeneration of bone is reviewed briefly at this time.

The supporting or connecting tissues of the body may be divided according to the differences in intercellular ground substance, on a basis of physical and chemical structure, into three groups: connective tissue, cartilage, and bone.

In a comprehensive view of these tissues, bone and cartilage may be regarded as adaptive derivations of connective tissue. They are all derived from primitive mesenchyma and have relatively equal importance from the standpoint of their evolution.

It is noted that each of these tissues may be replaced by one of the

*From the Department of Surgery, School of Medicine, Yale University.

others, either in whole or in part. Bone may develop from or revert to connective tissue. Cartilage may be replaced by bone or develop connective tissue in its substance.

Evolutionary types of connective tissue show different degrees of adaptation and complexity of structure. Connective tissue in the embryonic form is composed of an abundant fundamental substance containing very fine fibrillae.

Undifferentiated connective tissue during the process of functional adaptation presents various structural types. It may become densely fibrous or loose connective tissue with varying degrees of tensile strength or elasticity. Transformation of these evolutionary types may assume an altogether different character by becoming impregnated with calcium salts. This adds the quality of rigidity for resisting compression and sheering strains. When the calcium deposition occurs in a highly differentiated tissue, the resulting structure or bone is fibrous in character. When ossification occurs in undifferentiated connective tissue, the result is dense, hard bone. It becomes evident then that resistant bone, having great mechanical value, is developed from embryonic or undifferentiated connective tissue and that fibrous bone, having relatively little resistance, is the result of ossification of more complex or highly specialized tissue. The strength of bone is therefore inversely proportional to the histological differentiation of the connective tissue from which it develops.

This concept of bone development is of great practical interest in the study of fracture repair, because ossification limits further differentiation of the embryonic type of connective tissue which initiates callus formation and is itself conditioned by the degree to which this specialization has progressed.

The histology of bone, like other supporting tissue, shows its differential characteristics in the intercellular ground substance. Undifferentiated or embryonic connective tissue has a relatively large amount of fundamental substance consisting of very fine fibrillae which form a delicate network without definite directional arrangement or bundle formation. The cells are large fibroblasts, some of which have prolongations extending to and joining neighboring cells. This mesenchymatous or embryonic tissue is suitable for a variety of adaptive changes and growth. It may be richly supplied with capillaries or contain very few; in the latter case the nutrition is supplied by diffusion.

The repair process in supporting tissues is initiated by the appearance of this embryonic or granulation tissue. By an increase in amount associated with directional arrangement of the fibrillae a fibrous adaptation is accomplished. It is then no longer an embryonic type and is less subject to morphological adaptation.

The hematopoietic tissue of bone marrow is the product of the invasion of undifferentiated connective tissue by blood vascular elements. It is therefore not a bone element but an invading and attached vascular element.

Bone as calcified connective tissue incorporates certain fundamental elements:

(a) Fibrillae, the network of connective tissue.

(b) Bone cells.

(c) Matrix, the calcified ground substance surrounding fibrillae and cells.

The cells may disappear, leaving spaces designated as lacunae. Canaliculi, representing to a certain extent the cellular prolongations previously referred to, connect these cavities. Various types of bone present such fundamental elements in different structural arrangements and quantities. Three basic types are recognized:

(a) Embryonic bone, which is composed of a small meshed network without particular arrangement or structural stability and contains relatively few capillaries.

(b) Spongy bone has a similar arrangement but the framework is much thicker and the spaces larger. The spaces in this type of bone are secondarily filled with fat or hematopoietic tissue.

(c) Compact bone is composed of a strong, thick framework with small connective-tissue spaces which do not contain hematopoietic elements. This original framework delimits the lamellar systems arranged around the canalicular spaces containing a single blood capillary.

The canals have a directional arrangement parallel to the long axis of the diaphysis. This structural composition is described as haversian bone. The primary forces involved in this structural adaptation are not known.

The literature concerning the source of the factors involved in the repair of structural defects resulting from injury to animal tissues consists of more or less interesting hypotheses. They relate to forces contained within the organism and to those external to it. One of these, referring to the cicatrization of open wounds, assumes that the defect or loss of tissue causes regeneration by removing resistance to cell proliferation; another, that the cells are directly stimulated to multiplication by forces outside the organism acting on tissues deprived of their natural protection. Experiments with wounds covered with dead connective tissue and control wounds not so protected seemed to indicate that external irritation or stimulation hastened the rate of cicatrization.

A rational view of why a fracture unites may be that it is not the ordered sequence of phenomena set in motion by the organism in a purposeful effort to restore the integrity of a structure, but that it is simply the unordered chemical and physical reaction of the local tissues to a force which has broken their previous continuity. Certain biological events occur in rapid sequence as the primary result of traumatism which exceeds the elastic limits of the tissue in question. Individual elementary histological changes follow fracture, hemorrhage, and vasodilatation. These changes are at first independent, but progress in a short time to a relation of mutual influence. Vasodilatation and circulatory obstruction, the result of altered anatomical relations, produce congestion and distention of the

soft-tissue lymph spaces. The hemorrhage coagulates, and later embryonic connective tissue appears. A resorption of the ends of the bone fragments occurs, freeing lime salts necessary for bone regeneration. From this point onward the conditions of ossification are present. No one of the preceding phenomena is unusual or necessarily limited to the process of bone repair but may be considered to have occurred unobjectively in juxtaposition, resulting in the healing process.

The inflammatory hypothesis of bone regeneration is interesting because osteitis, whether aseptic or infectious, which produces structural bone change, results in an association of phenomena similar to what has been described following trauma. This concept of the process seems beside the point since the preceding view does not maintain that other forces may not set in motion similar phenomena. It also tends to a confusion of the primary etiological factors.

Bone formation is described as occurring in three general types:

In the first type cartilage precedes bone, which is formed as a replacement of the former tissue. This is accomplished by a progressive resorption of cartilage with the substitution of undifferentiated connective tissue which becomes ossified.

In the second type bone is formed from connective tissue without cartilaginous antecedents. This indicates a direct process without the resorption of a preliminary cartilaginous model.

In the third type, which is described as having been observed in pathological processes, cartilage is converted directly into bone without resorption. The resorption of preexisting cartilage and bone was observed however in the vicinity of the areas of direct transformation.

The healing of a simple aseptic fracture of a long bone meets the requirements for comparison with the observations made in our study. Immediately following a fracture of this type, exposure of the fracture site reveals a hemorrhage between the fragments, which infiltrates the adjacent muscles and connective-tissue spaces. This extravasated blood coagulates, forming a fibrinous interfragmentary mass. The medullary tissue of the fragments is also infiltrated with blood for a short distance depending on the degree of trauma. Examination of the traumatized area on the fourth day shows the infiltrating medium to be gelatinous in character and not a free fluid. Studies of the healing process in soft tissues indicate that fibrosis starts on the fourth day.

Owing to the absence of proof of the exact mechanism of the process and the theoretical nature of the literature as to the activity or rôle taken by certain elements such as fibroblasts and osteoblasts, only the more or less objective features of the process will be mentioned in reviewing the successive stages.

The initial fibrous organization seems to be reasonably explained by the budding out of soft connective-tissue processes from the surrounding tissues, especially the haversian canals and the periosteum. The granulations coming from the haversian canals may be seen with the naked eye in con-

trast with the dull white of the bone. These processes penetrate the coagulum accompanied by a new formation of capillary vessels which finally make contact with each other in a period of time depending on the size of the clot or the degree of separation of the fragments. In fractures associated with great trauma and wide displacement, with subsequent motion of the fragments, the fibrin may become unequally distributed in the clot, resulting in serous accumulations or cysts. In any event, such accumulations of fluid have frequently been observed, and since fibrous tissue does not invade liquids, no intrafragmentary organization can take place under such conditions. Clinical experience coincides with the foregoing conceptions, because fractures with slight separation or early anatomical adjustment usually show primary fixation. The early cystic obstruction to fibrous organization may be the first step in some otherwise unexplained series of untoward phenomena observed in malunion and non-union as a later manifestation. The relatively great abundance of blood supply at the osteoperiosteal junction in children undoubtedly promotes rapid connective-tissue formation and organization.

Coincident with the organization of the coagulum there is a progressive resorption of the ends of the bone fragments which is usually associated with the stripping up of the periosteum and other alterations in the circulation. This feature of the process is checked by noting the increased radiability of the fragments and histologically by the enlargement of the haversian canals and tissue spaces. A sequestrated fragment shows no resorption and it has also been noted that necrosis of bone ends is not associated with callus formation. These and other observations have led to the interesting hypothesis that the calcium salts liberated by bone resorption constitute at least a part of the calcium concentration necessary for ossification of the connective tissue conditioning true callus formation.

With the structural organization of the coagulum, by its invasion with undifferentiated connective tissue accompanied by newly formed vascular elements, there is developed an ossifiable medium between the bone fragments and underneath the stripped-up periosteum. In the absence of definite knowledge as to the exact mechanism of the process it may simply be said that calcium is found deposited in this connective-tissue medium as early as the sixth day. This has been primarily seen in the osteoperiosteal angle. Bone granules have been observed in the adjacent muscles as early as the ninth day. Ossification progresses, with bone trabeculae appearing in the perivascular tissue and in a general direction parallel to it. The resulting haversian structure of the callus may then have a directional arrangement not parallel with the haversian canals of the fragments and it follows that interfragmentary ossification with fusion from one end to the other of the vascular connective tissue elements of the haversian canals does not occur until some time after the development of firm callus. It must follow a period of resorption and reorganization of the callus between the fragments. This has been placed by some observers at a minimum of thirty-five days. A minimum of twenty-five days is the clinically accepted

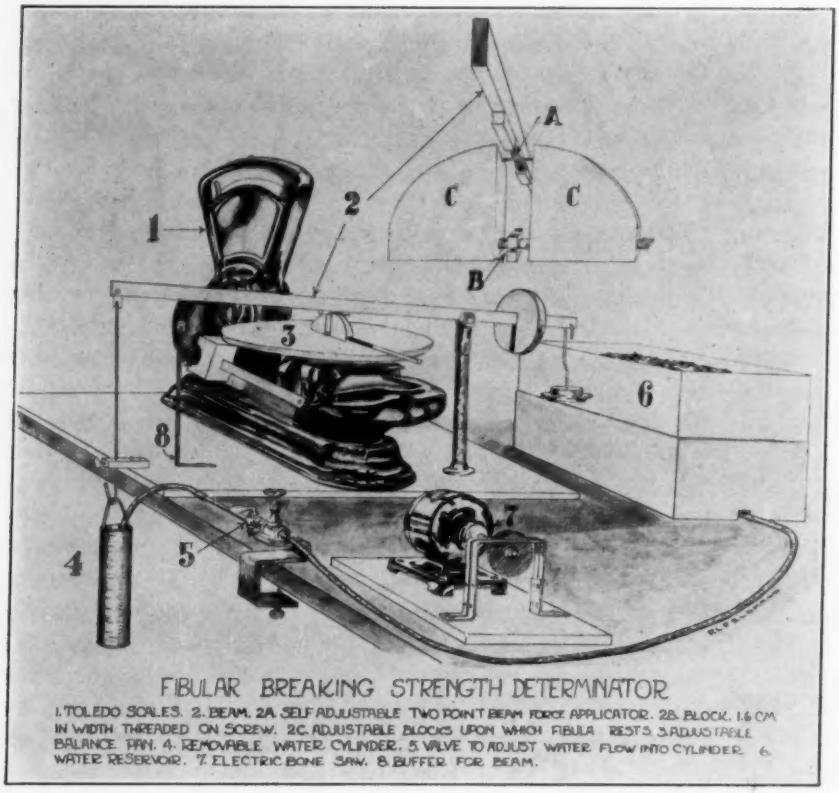
time requirement for the development of firm callus. These figures are for complete simple fractures of the shaft of the long bones.

The object of the preceding discussion has been to present as accurately as possible the accepted anatomical and clinical data with reference to the normal or average healing of bone.

For the purpose of establishing a basic curve representing the normal healing rate of fractures, the return of strength was measured following a constant fracture in an animal whose metabolic processes have been thoroughly studied. To meet this requirement the rat was chosen.

EXPERIMENTATION

Following the considerations mentioned in the introduction, a device was constructed of sufficient sensitivity and accuracy to measure the transverse strength of the fibula of the rat. This bone was chosen in order to minimize the effects of disuse atrophy and to avoid the error of inconstant artificial splinting. The fibula of the rat is fused at its lower extremity to the tibia which acts as a constant natural splint. The testing device (Fig. 1) consisted of a standard Toledo scale provided with a support for the bone and a balanced lever arm for applying the force. The support con-



FIBULAR BREAKING STRENGTH DETERMINATOR

1. TOLEDO SCALES. 2. BEAM. 2A. SELF ADJUSTABLE TWO POINT BEAM FORCE APPLICATOR. 2B. BLOCK. 1.6 CM. IN WIDTH THREADED ON SCREW. 2C. ADJUSTABLE BLOCKS UPON WHICH FIBULA RESTS. 3. ADJUSTABLE BALANCE PAN. 4. REMOVABLE WATER CYLINDER. 5. VALVE TO ADJUST WATER FLOW INTO CYLINDER. 6. WATER RESERVOIR. 7. ELECTRIC BONE SAW. 8. BUFFER FOR BEAM.

FIG. 1

sisted of two weight-bearing sections placed in such relation as to form a constant span. The force was applied at two points on the bone at a fixed distance from the fracture site. With the bone resting on the supports, the force was applied at a uniform rate by allowing water to escape slowly from a reservoir into a container attached to the free end of the lever arm. The valves on the water line were so adjusted as to maintain a constant rate of flow which insured a uniform method of applying the force, — the flow of water was stopped when the weight of a given volume acting through the lever arm was sufficient to break the bone. With the lever arm resting on the support following the break, the force measured in five gram units was then read as a fixed point on the scale. The bones were all placed on the support in the same relative position for breaking.

The animals employed for the test were apparently healthy young adult males. Their individual weights varied between 150 and 300 grams.

The rats were narcotized with ether under a bell jar and carried lightly during the operative procedure by placing a small glass containing ether-moistened cotton near the nose. The right leg was used in each case and was prepared by clipping the hair and applying tincture of iodin which was removed with alcohol. With the leg protected by a small drape, a longitudinal incision two centimeters long was made on the lateral aspect and carried down to the fascia at the anterior border of the gastrocnemius. Dividing this fascia and retracting the soleus exposed the fibula to view. The most prominent point on the anterior aspect of the tibia was easily located with the finger. Directly opposite this the fibula was fractured by being cut through with the sharp points of a pair of scissors. This resulted in the bone being divided opposite a constant anatomical landmark with the same amount of destruction of bone in each case. No ligatures were used as the procedure is practically bloodless and of extreme simplicity. The fascia and skin were closed with continuous silk. In two hundred and fifty operations, one wound infection occurred. Following the procedure, the animals were placed in separate cages and were observed to walk on the fractured legs in periods varying from the time of recovery from the anaesthesia to twenty-four hours after. A standard diet, modified after Moise and Smith, was given and the food intake and the animals were weighed every three days. As stated in the introduction, no conclusions are drawn as to the effect of this diet. It is simply mentioned as a constant condition in this problem.

FORMULA FOR STANDARD DIET

Percentage composition		Calories per kilogram of food	Apportionment of total calories	
	Per cent.			Per cent.
Casein	18	738	Protein	13.8
Starch	51	2,091	Carbohydrate	39.2
Crisco	22			
Cod liver oil	5	2,511	Fat	47.0
Salts, Mendel and Osborn mixture	4	5,340		

Lettuce twice a week; 100 milligrams of yeast per day; water *ad lib.*

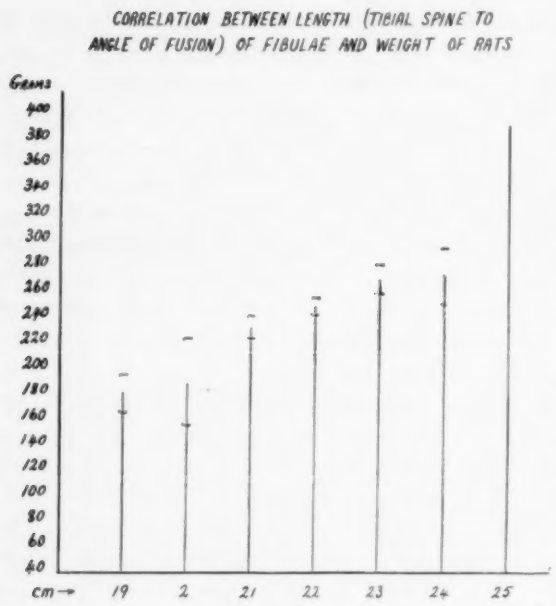


CHART I

Five rats were sacrificed at three-day intervals and the legs removed. The muscles were stripped from the leg bones which were then placed for twenty-four hours in a desiccator. After drying, the sections of the tibiae opposite the fibulae were cut away with a small high-speed circular saw. The motor saw was used because other methods of cutting resulted in splintering the bone.

The sacrificed animals were examined generally for pathology, and if such was discovered the animal involved was not used in the present study.

Placing the bones in the same relative position on the support for breaking resulted in the middle loads of the lever being applied on either side of the fracture point. For the purpose of fixing the length of the span to be used, it was necessary to find the average length of many normal rat fibulae. Chart I gives this data and the relationship between the bone length and the weight of the animal. It will be noted that the length of the normal fibula varies between one and nine-tenths and two and four-tenths centimeters. If one-half centimeter is substracted from the length of each bone to allow for the portion in contact with the bearing surfaces of the support, the span should then vary between one and four-tenths centimeters and one and nine-tenths centimeters. Since the span must be constant it was set at the distance representing approximately the mean of the extremes considered. A study of Chart I, in which the averages are computed, will show that the length of the bone is in direct proportion to the weight of the animal. The next step in the problem was the determination of the relationship between the length of the normal or unfractured fibula and its breaking strength over a constant span. For these measurements more definite landmarks were selected,—distally the angle of fusion between the tibia and fibula, and proximally the tibial spine. This measurement has the advantage of being more accurately determined and is more constant although it averages two-tenths of a centimeter longer than the fibula itself. Chart II gives the relationship between these two factors and indicates that the breaking strength with span constant varies directly with the length of the bone. It is therefore apparent that the strength is in direct

proportion to the length which is in direct proportion to the weight of the animal.

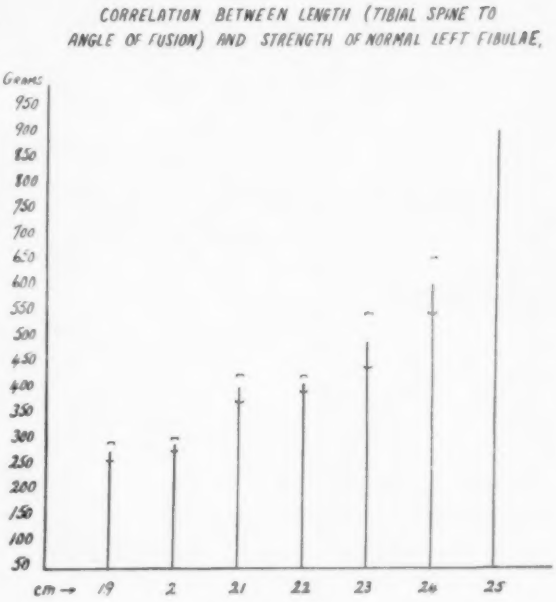


CHART II

The average range of breaking strength of fibulae not previously fractured was between 285 grams and 580 grams. The break in these normal bones usually occurred at the junction of the middle and lower thirds with an inconstant discrepancy in breaking strength between the left and right. This discrepancy was found, however, to be less than that encountered in testing laboratories where the beam test was applied to samples cut from a single variety of wood or to samples composed of cast iron. This indicated that our technique was giving results comparable to accepted mechanical standards.

RESULTS

The examinations of the healing fractures at the time of testing showed no overriding, angulation, or appreciable lateral displacement.

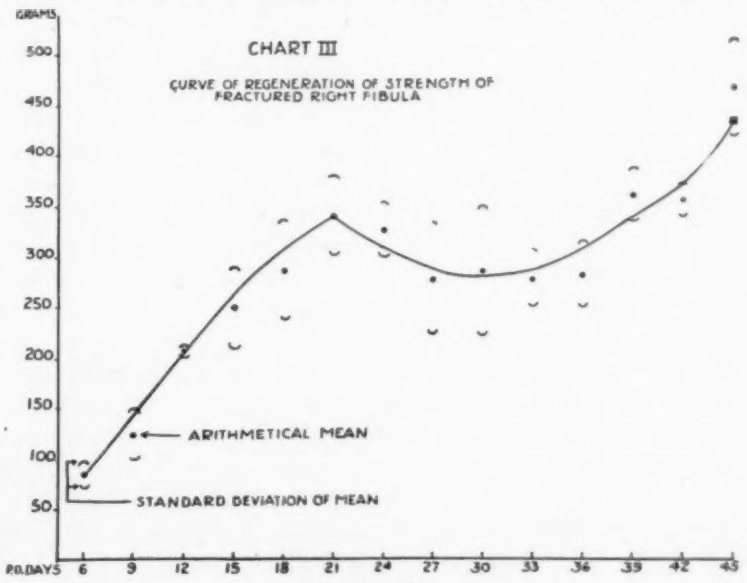


CHART III

TABLE I.

CURVE OF REGENERATION OF STRENGTH OF FRACTURED RIGHT FIBULAE

Postoperative days	Mean	Standard deviation of mean
6	85	±13
9	125	±24
12	209	±4
15	250	±40
18	288	±48
21	341	±39
24	328	±22
27	277	±57
30	285	±62
33	277	±28
36	282	±33
39	357	±25
42	353	±18
45	465	±44

The size of the callus was proportionately progressive with the breaking strength up to the twenty-first day. Chart III gives the return of strength in the fractured bone and Table I the actual figures with the standard deviation of the mean computed. It will be noted that there is no strength before the sixth day, but that after this time it mounts rapidly until the twenty-first day. It then diminishes until the thirtieth day only to rise again to a new high level. All the breaks except two occurred at the fracture site. Those recorded on the forty-fifth day broke simultaneously at the fracture site and elsewhere.

The figures here given are uncorrected for the difference occasioned by the variations in the cross sections of the fibulae, because of the inadequacy of mensuration which would give a true cross section of the bone at the point of fracture, and from which strength per unit area could be calculated. The observations give a fair approximation without correction. There was also some confirmatory evidence on examination of the fracture site that might be correlated with the variation of strength seen in this curve. It was noticed that the callus grew steadily in size until the twenty-first day and then gradually diminished until the thirty-ninth day when it was approximately reduced to the diameter of the bone on either side of it. Also, on examining the bone against a strong light the translucency of the shaft was seen to be diminished for a slight distance on either side of the callus. This relative opacity increased and diminished in direct proportion to the size of the callus.

DISCUSSION

The observations made in this study conform to the histological data recorded for healing bone. The first part of the process concerned with fibrosis cannot be measured by a breaking point, but the second period dealing with ossification permits a comparison. As previously stated, bone has been observed in an elementary form as early as the sixth day. This observation has been made on both human and animal subjects, including the rat. The clinical finding of firm callus on the twenty-fifth day

is a striking parallel with the curve showing a primary maximum strength developed on the twenty-first day. The histological observations of gradual increase of calcium deposition in the evolutionary tissue explain the gradual rise in the curve up to this first maximum point. The loss of strength after the twenty-first day is in accord with the histological period of resorption preceding reorganization. From the thirtieth to the forty-fifth day the returning strength indicated by the curve coincides with the directional reorganization of the trabeculae and haversian systems in conformity with the directional arrangements of these structures in the uninjured portions of the shaft. Leriche states that the healing rate of bone has been the same for all animals investigated by him.

This paper represents an outline of the first step in a study of bone regeneration based on its breaking strength. It is simply a statement of what was done and the observations made. In the preliminary work on this problem possible sources of error were observed and further studies are now being conducted in an effort to eliminate them.

SUMMARY

1. A quantitative method is described and a basic curve developed, indicating the breaking strength of regenerating bone.

2. Strength first manifests itself by the sixth day and then increases rapidly to the twenty-first day. It was observed that the callus grew steadily larger during this time.

3. There is a period of decline in strength after the twenty-first day, during and following which time the callus decreases in size.

4. There is a secondary rise in strength from the thirty-third to the forty-fifth day.

5. A strength is attained on the twenty-first day which is comparable to that on the thirty-ninth, but a period of weakness exists between the two.

6. There is a direct correlation between the results of this study and previously observed histological facts and clinical data.

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STABILIZATION OF THE FOOT
A Study of Late Results

BY LEO J. MILTNER, M.D., PEIPING, CHINA

From the Department of Orthopaedic Surgery, School of Medicine, State University of Iowa.

Stabilizing operations on the foot for curative and restorative purposes are now standard procedures in all orthopaedic clinics. Many different operative methods have been devised, each having slightly different anatomical, physiological, and kinesiological principles; and each in turn finding its place as the operation of choice in a certain type of foot. The fundamental principles of realignment, stabilization, and rebalancement are applied in all cases, so that, even though the technique varies according to personal preferences, the end results are almost uniformly successful.

In the Orthopaedic Clinic at the State University of Iowa over 400 arthrodesing operations on the foot were performed prior to 1928. Ninety per cent. of these patients have been returning to the hospital for postoperative observation over a period varying from two to fifteen years. Through the generosity of Dr. Steindler it is the privilege of the author to publish the following clinical findings and statistical data.

ASTRAGALECTOMY

Table I presents an analysis of the results of a series of 122 astragalectomies[1,2,3] performed over a period of fifteen years. The indications for this type of operation were mainly paralytic pes calcaneus, paralytic pes calcaneovarus, paralytic pes calcaneovalgus, and paralytic pes calcaneocavus. Other conditions for which the procedure was used followed "crush" fractures of the astragalus, tuberculosis of the ankle, and severely deformed club-foot.

Astragalectomies were performed on 112 cases for calcaneus and dangle-foot deformities of infantile paralysis. The functional results were satisfactory in all cases, except in those in which there was complaint of severe pain. In this group there were twenty-eight patients who returned after operation, complaining of pain in the region of the tarsal bones. In twenty-three the pain was very mild and was noticed only upon fatigue. In five cases the pain was so severe that the patients returned repeatedly to the clinic, seeking relief. These patients were all persons over fifteen years of age, engaged in occupations that demanded excessive use of the impaired extremities. Other causes for the pain were found,—such as, (1) operative errors in alignment of the foot; (2) loose fragments of bone in

the tibiocalcaneal mortise; (3) traumatic arthritis; (4) recurrence of deformity with uneven distribution of pressure in weight-bearing. Recurrence of deformity resulted from one of two factors,—marked muscle imbalance, or secondary growth changes. Most of the patients who showed a recurrence of a previous deformity (usually metatarsus varus) were under fifteen years of age.

Whitman's operation was performed in four cases for chronic pain after "crush" fractures of the astragalus, and in three cases for tuberculosis of the ankle. Two of the former continued after operation to have slight pain upon walking. This was due to chronic ligamentous strain along with mild circulatory disturbance of the foot. Of the three patients operated upon for tuberculosis of the ankle, one died of a miliary infection which was apparently initiated by operative interference.

TABLE I

STATISTICS ON ASTRAGALECTOMIES TO 1928

Total number of operations—128
Time of postoperative observation—one to fifteen years
Average length of time observed, all cases—four years
Number of cases available for study—122

DIAGNOSIS	RESULTS					
	Pain	*No. of cases*	*Function*	*No. of cases*	*Form*	*No. of cases*
Infantile paralysis, 112 cases	Not painful	84	Good	101	Good	98
	Slightly painful	23	Fair	6	Fair	7
	Very painful	5	Poor	5	Poor	7
Fracture of astragalus, 4 cases.	Not painful	2	Good	3	Good	3
	Slightly painful	2	Fair	1	Fair	1
Tuberculosis of ankle, 3 cases. (1 patient died of miliary tuberculosis.)	Slightly painful	1	Good	1		
	Very painful	1	Fair	1		
Congenital club-foot, 1 case.	Not painful	1	Good	1	Good	1
Spastic hemiplegia, 1 case.	Slightly painful	1	Fair	1	Good	1
Congenital contractures, 1 case.	Not painful	1	Good	1	Good	1

TARSAL STABILIZATIONS

In Table II are recorded all the arthrodesing operations which involved the tarsus. These operations were studied together because in many instances the classical technique was modified, or, as so frequently happened under the direction of Dr. Steindler, the essential principles of one or more of the methods of arthrodesis were used in a single case. These operations were (1) the Hoke arthrodesis[4]; (2) the subastragaloid arthrodesis of Davis[5]; (3) the triple arthrodesis of Ryerson[6]; (4) the arthrodesis of Dunn[7]; (5) the osteoplastic operations of Jones[8].

Arthrodesis of the subastragaloid and of Chopart's joint was the major procedure in most of the cases in Table II. The details concerning the amount of bone removed and the type of wedge resected varied in every case, depending upon the type of deformity and the extent to which it was desired to displace the astragalus forward.

Dr. Ryerson's triple arthrodesis[6] was usually indicated in a foot showing but mild deformity with satisfactory control of the flexors and extensors of the ankle. In those feet wherein it was not felt necessary to set the astragalus forward, the triple arthrodesis was the operation of choice. The final result in almost every instance of Ryerson's arthrodesis was excellent.

Eighty-five per cent. of the operations listed in Table II were performed according to the principles of Hoke[4], but with certain modifications. The changes from Hoke's original description included in most instances a complete removal of the head of the astragalus and also removal of as much of the neck of the astragalus as was found necessary to allow for the forward displacement of the talus. In addition, the calcaneocuboid joint was fused. As a general rule the muscle balance of the ankle and foot determined the extent to which the astragalus was set forward. In those cases, in which because of severe static deficiencies, it was highly desirable to secure forward displacement of the astragalus on the os calcis, the oper-

TABLE II (A)

STATISTICS ON ARTHRODESIS OF TARSUS TO 1928

Total number of operations—185
Time of postoperative observation—one to ten years
Average length of time observed, all cases—three years
Number of cases available for study—143

DIAGNOSIS	RESULTS					
	Pain	*No. of cases*	*Function*	*No. of cases*	*Form*	*No. of cases*
Infantile paralysis, 116 cases	Not painful	114	Good	114	Good	100
	Slightly painful	1	Fair	1	Fair	10
	Very painful	1	Poor	1	Poor	6
Spastic paralysis, 17 cases.	Not painful	15	Good	15	Good	8
	Slightly painful	2	Fair	2	Fair	6
			Poor	0	Poor	3
Progressive muscular dystrophy; Friedreich's ataxia, 5 cases.	Not painful	5	Good	5	Good	5
Spina bifida (paralytic), 2 cases	Not painful	2	Good	2	Good	2
Traumatic peroneal palsy, 1 case.	Not painful	1	Good	1	Good	1
Chronic infectious arthritis, 2 cases.	Not painful	0	Fair	2	Good	2
	Slightly painful	2				

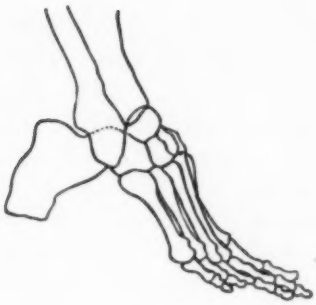

FIG. 1

Diagram to illustrate position of bones after Whitman's astragalectomy. Note marked backward displacement of foot and equinus position.

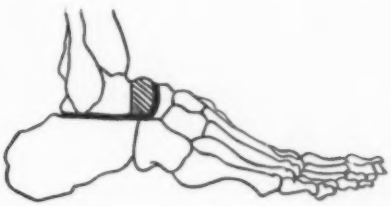

FIG. 2

Diagram of result after Hoke type of operation, showing the two-joint arthrodesis and the remodeled astragalar head back in place.

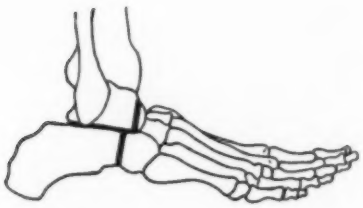

FIG. 3

Diagram of result after Steindler's modification of the Hoke arthrodesis. Note complete removal of head and most of neck of astragalus. This is a three-joint arthrodesis allowing considerable forward displacement of the astragalus.

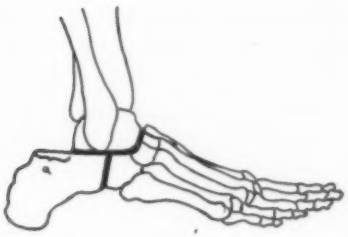

FIG. 4

Diagram of result after stabilization of a mild calcaneocavus foot by the "Dunn type" of arthrodesis. This is an extensive three-joint arthrodesis in which there has been a complete removal of the scaphoid bone, and of the head and most of the neck of the astragalus. By this procedure backward displacement of the foot is second only to that in the astragalectomy.

ation of Naughton Dunn[7] was indicated. Excepting astragalectomy, the procedure of Dunn allowed for the most forward displacement of the astragalus. Forward transference of the fulcrum (the ankle) to a position nearer the center of the foot was found to be of great advantage for function, especially in the cases showing mild calcaneus and cavus deformities.

The subastragaloid transverse horizontal section of G. G. Davis was used in a few selected cases for the lateral deviation of the mild paralytic foot. It allowed but little backward displacement of the foot; hence it was reserved for those instances wherein the only deformity was mild pronation or supination of the os calcis. Simple wedge osteotomies[8] of the tarsus were performed in a few cases.

Excellent results were found in ninety-five per cent. of the cases listed in Table II (A). Only six of the 150 cases complained of persistent after-pain. Two of these painful feet occurred in patients who had chronic

infectious arthritis and here the pain was due to persistent periarthritis about the tarsus. The results among the paralytic cases were uniformly satisfactory. Sixteen of the 116 paralytic feet showed some return of the previous deformity. The recurrent deformity was noted either among patients who were under twelve years of age, or among patients to whom insufficient attention was given regarding tendon transplantation. Incomplete fusions should also be mentioned in this connection. Operative errors, particularly in patients under twelve years of age, were the cause of most of the incomplete fusions. Eight cases were reoperated upon because of fibrous union with recurrent deformity.

Arthrodeses were done in seventeen instances for severe deformities due to spastic paralysis. Nine of the seventeen cases showed some recurrence of deformity after several years of observation. This incidence was very striking. After analysis of these cases it was evident that even though the operation had been perfectly performed, and the bones solidly fused, the combination of growth changes and uncontrollable muscle imbalance would reproduce deformity.

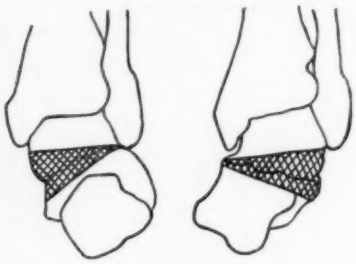

FIG. 5

Posterior view of valgus and varus deformities. The shaded areas indicate the character of bone wedges necessary to correct the deformities.

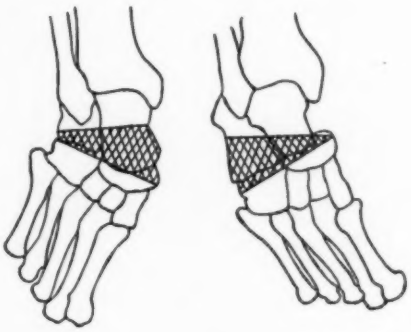

FIG. 6

Diagram to illus'rate essential principles in osteoplastic operations of Jones. Note the type of bone incisions and the character of wedges for correction of adduction and abduction deformities.

TENDON TRANSPLANTATIONS

In Table II (B) the results of tendon transplantation have been summarized. All of these operations were performed in conjunction with arthrodeses, but in this study, as nearly as possible, a separate analysis of the end results was made. Of the twenty-five tendon transference operations the results were good in seventeen cases, fair in five cases, and poor in three cases. Under "good results" were placed only those cases wherein the transposed tendons showed active function with good power. The factors which seemed to be of most importance in securing good end results were: (1) proper physiotherapeutic guidance for the reeducation of the transposed tendons; (2) secure fixation of the tendons with the correct amount of tension[9,10,11]; (3) attention to the problems of prevention of adhesions[12,13,14,15] and maintenance of nutrition of transplanted tendons[16,17].

The type of transplantation which was performed in a given case followed quite closely certain general rules which may be summarized as follows:

Severe calcaneus deformity. In cases of severe calcaneus deformity the Whitman astragalectomy was indicated.

Mild calcaneus deformity. In cases showing strong dorsiflexors of the ankle and weak plantar-flexors, the active peroneal tendons and the tibialis posticus were considered for implantation into the tendo achillis or into the os calcis.

Mild equinus deformity. In cases showing weak dorsiflexors of the ankle and very strong plantar-flexors, the peroneal tendons and the tibialis posticus were considered for implantation either into the dorsum of the tarsus or into the toe extensors.

Severe equinus deformity. In these cases tendon transplantation, when used, was considered only as an accessory factor in controlling the equinus. Depending upon the indications, any one or more of the following operative procedures were used to control the equinus position: (1) backward displacement of the foot as in the modified Hoke or Dunn operation; (2) lengthening of the tendo achillis; (3) tenodesis, using the inactive peroneals and the tibialis anticus for implantation into the tibia; (4) bone-block operation for drop-foot (Campbell[18]).

Lateral deformity of the foot. In all cases arthrodesis was depended upon to control lateral deformities of the foot. In nine cases among the

TABLE II (B)

TENDON TRANSPLANTATIONS ACCOMPANYING TARSAL STABILIZATIONS—TWENTY-FIVE CASES

AVERAGE LENGTH OF TIME OBSERVED, ALL CASES—THREE YEARS

Type of transplantation	*Number of operations*	*Results*		
		Good	Fair	Poor
Peroneus longus to insertion of tibialis anticus. (Biesalski and Mayer)	9	5	2	2
One of peronei to extensors of toes.	3	3		
Peroneus (longus or brevis and tibialis anticus or posticus) into bone of mid-tarsus for dorsiflexors.	9	6	3	
Peroneus longus to extensor longus digitorum and peroneus brevis to extensor longus hallucis.	2	2		
Peroneus longus and brevis and tibialis posticus through drill hole in os calcis for plantar-flexion.	2	1		1
Tenodesis of tibialis anticus and peroneus brevis into tibia to prevent foot-drop.	4	3		1
Campbell bone-block (to prevent foot-drop).	9	6		3

young growing feet it was thought necessary to transplant one of the active peroneals to the insertion of the tibialis anticus (Biesalski and Mayer), to give additional support to the inner longitudinal arches. Wherever possible a normal balance of lateral muscle power was created. After full consideration of the strength of the active peroneal and tibial muscles, the tendon transplantation was performed, so that there remained a moderate preponderance of muscle power for the support of the inner arches as compared with the muscle power acting upon the outer long arches.

PANASTRAGALOID ARTHRODESIS

Steindler lists the indications for panastragaloid arthrodesis[21] as follows[19,20]:

"In paralytic flail-foot when the foot is not deformed nor has any tendency to contractures, especially varus or cavus deformities, it is desirable that the knee be in good condition or at least that a fair amount of flexors of the knee be present. Absence of the extensors of the knee does not contraindicate the operation, because the arthrodesis serves to stabilize the joint." Other indications were in exceptional cases of osteomyelitis (tuberculous or pyogenic) about the astragalus, and in post-traumatic arthritis.

TABLE III

STATISTICS ON PANASTRAGALOID ARTHRODESIS TO 1928
Total number of operations—87
Time of postoperative observation—one to fifteen years
Average length of time observed, all cases—four and one-half years
Number of cases available for study—74

DIAGNOSIS	RESULTS					
	Pain	*No. of cases*	*Function*	*No. of cases*	*Form*	*No. of cases*
Infantile paralysis, 68 cases.	Not painful Slightly painful	58 10	Good Fair	63 5	Good Fair	61 7
Post-traumatic arthritis, 3 cases.	Not painful	3	Good	3	Good	3
Tuberculosis of ankle, 2 cases	Not painful	2	Fair	2	Good	2
Chronic osteomyelitis, astragalus, 1 case.	Not painful	1	Good	1	Good	1

Of the sixty-eight cases of infantile paralysis operated upon (Table III) there were ten patients who complained of pain at times. In four of these the pain was entirely relieved by balancing the foot with shoe corrections. In three cases the pain appeared only after excessive exercise. In no case was the pain severe or constant. In four of the painful feet the pain was located in the forefoot in the region of Lisfranc's joint and the

metatarsal bones. In these cases ligamentous strain and traumatic periosteal irritation, away from the operative field, were the cause of the pain.

Seven of the paralytic cases showed a return of the previous deformity. There were sixteen patients under ten years of age operated upon, four of whom showed incomplete fusion (25 per cent.). These four cases had a recurrence of the deformity. The matter of an incomplete fusion in patients over ten years of age can be explained mainly on the basis of operative errors.

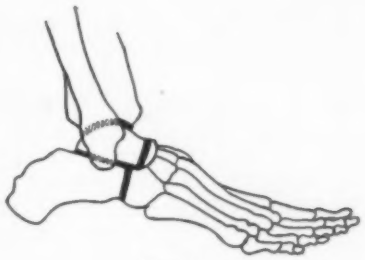

FIG. 7

Diagram to illustrate panastragaloid arthrodesis of Albee and Steindler. The calcaneocuboid joint may be fused if necessary for stability or correction of deformity. Perfect lateral alignment and 20 degrees' plantar-flexion is the most suitable position of fusion.

The three cases of post-traumatic arthritis in which panastragaloid arthrodeses were performed all gave excellent results. Two cases of tuberculosis and one of osteomyelitis were also followed by good results after operation. In the latter three cases the infection was of a mild, chronic nature, most of the involvement being in the joints about the astragalus.

SUMMARY

Stabilizing operations have proved to be very satisfactory procedures in over eighty-five per cent. of the cases in this series. The addition of tendon transplantations to stabilizing operations has definitely improved the results. Each of the operative procedures (Whitman, Hoke, Dunn, Ryerson, Jones, Albee, and Steindler) has a place in the reconstructive surgery of the foot. No one of these operations can be employed satisfactorily in all cases. Careful muscle analysis will determine the indications for the procedure of choice.

The author wishes to express his appreciation to Dr. Cowart, Dr. Lowendorf, and Dr. Grieve for their help in making the statistical studies.

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THE DOUBLE-LEAF SHELF OPERATION FOR CONGENITAL DISLOCATION OF THE HIP

BY C. L. LOWMAN, M.D., F.A.C.S., LOS ANGELES, CALIFORNIA

Having experienced the difficulty of turning down a flap from the side of the ilium for the purpose of making a roof for a false acetabulum, and making it stay in position, it seems appropriate to report a method of overcoming the difficulty.

A few years ago, after such an operation, Dr. Galloway and the writer discussed this factor as the chief problem of the whole procedure; and, as we had both experienced trouble at this point, I decided to try to overcome it.

Our technique is as follows. After the usual Smith-Petersen incision, the periosteum is peeled from the side of the ilium down to a point a little below the level of the head, which is pulled down as low as possible without

FIG. 1

Bilateral dislocation. Patient came in for sciatic pain. Preoperative, right hip. Bone cyst operated on first. Hip operation several months later.

FIG. 2

Same case as Fig. 1. Six months postoperative. Double-leaf shelf. Filling in very firmly.

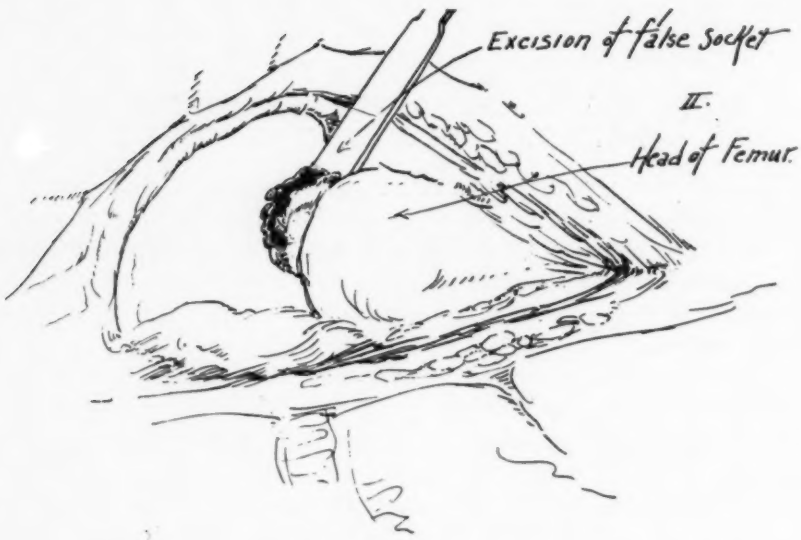

FIG. 3
Subperiosteal dissection down to rim of old acetabulum. Head pulled down as far as possible before new socket is formed.

too great stress, and brought forward to a position above the old acetabulum.

It will be recalled that running up the ilium in the direct line of weight-bearing from the roof of the normal acetabulum, there exists a thickened triangular ridge or buttress of the bone which is about one inch thick just above the socket and tapers down to about three-eighths of an inch toward the crest in the average individual after twelve years of age. After estimating about the proper level and position for the new acetabulum, we cut directly into this thickened area with a broad curved gouge, getting all the depth possible and taking out the bone in as large pieces as possible.

We have found the curved arthrodesis chisel which Robert Jones designed for ankle arthrodesis to be admirable for this purpose. The average socket is made from one and one-eighth to one and three-quarter inches in diameter and is usually from one-half to three-quarter inches in depth.

Next we outline with a small osteotome two rectangular flaps of cortex from just above the upper rim of this new socket, extending for about an inch upward—one forward and upward and the other backward and upward—the bases being downward, parallel with the upper margin of the rim. These bases of the flaps come within one-quarter inch of each other at the mid-point of the upper margin of the new socket. The upper adjacent corners of these flaps lie about three-quarters of an inch apart. With a broad thin-bladed osteotome these flaps are cut out carefully by insinuating the osteotome from above downward between the tables of the bone.

Before beginning to pry the flaps outward, a small hole is drilled in the upper adjacent corners about one-quarter to three-eighths of an inch away

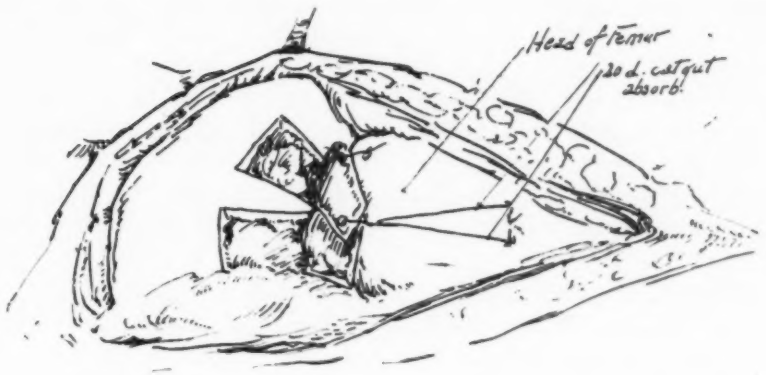

FIG. 4

Oblique flaps. Bases, parallel to but just above margin of new socket, bent down from two directions, make a concave roof over head.

from the margins. When the osteotome reaches a point about three-eighths of an inch above the margin of the socket, it must be angled so that the cut goes deeper and as nearly parallel to the top of the socket as possible, great care being taken not to break it loose at the base.

The marginal cuts may be made quite deep, and by going deep above the upper margins of the socket a rather springy hinge can be obtained.

Next an assistant pulls the leg down to an appropriate position so that the head with its coverings engages the new socket and holds it steady. The two oblique leaves are next carefully pried outward and, as the bases

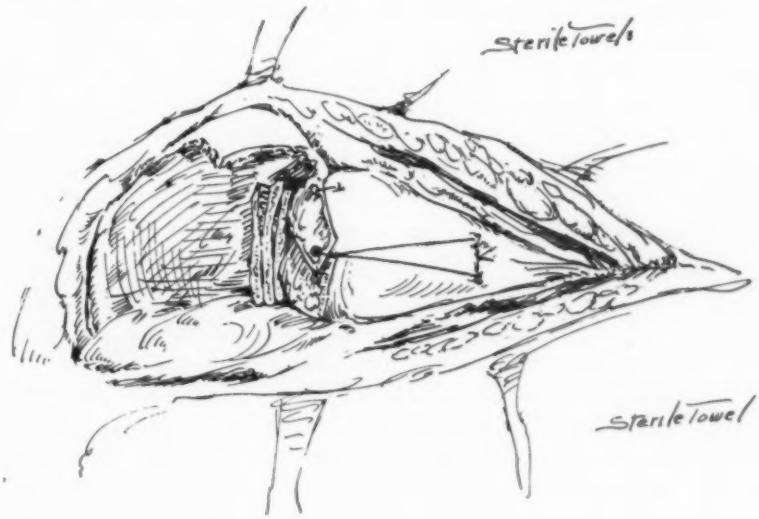

FIG. 5

Corners of flaps overlapped, tied together, suture carried down to trochanteric fascia. Bone chips piled above. Movement of leg toward adduction or downward from traction keeps flaps down.

or hinges of these flaps lie at an angle, the upper inner corners approach each other as the horizontal is reached. A stout No. 3 chromic suture is now passed through the holes in the flaps, the corners of which will now overlap, and is tied, leaving ends of the suture of at least four to six inches in length. One of these ends is rethreaded and, with the assistant making twenty or thirty degrees of abduction, this suture is passed into the deep trochanteric tissue, acting as a tether to pull on the flaps and assist in holding them down. However, after being tied together in this position, they cannot spring back readily.

All the extra bone chips are now fitted snugly into position above the flaps, especially into the deep track of the osteotome, forming the substance for a buttress of bone to later take the thrust of weight-bearing. The muscle mass with the periosteum is now replaced on the ilium and the triangular space above the flaps in which the bone chips lie is now under the periosteum and thus in position to become well nourished, remain viable, and produce a large firm buttress sufficient to carry a very firm thrust.

The use of two flaps instead of one allows them to be fastened in the manner described, which prevents their springing back. Still more important, they form a concave area to receive the head rather than a flat one. This allows a greater range of flexion and extension without as much danger of dislocation. The temporary check suture is used so that while the cast is being put on any loss of abduction only pulls the flaps down into a better position.

A short double spica is used and traction straps put on below the knee. Later, five to ten pounds of traction is used to overcome the tendency to spasm. Any pull down on the leg will also pull on the check suture and hold the flaps down.

The cast is removed or split after eight weeks to permit physiotherapy. When possible, exercises in a pool are given, the patient horizontal at first, then walking in deep water. This allows the muscles to develop, by graduating the weight which is carried by the buoyancy of the water. Gradation of the depth of the water controls the amount of weight on the shelf. A splint is used until the bone is hard.

TRANSPLANTATION OF THE BICEPS FEMORIS FOR THE RELIEF OF QUADRICEPS FEMORIS PARALYSIS IN RESIDUAL POLIOMYELITIS*

BY C. H. CREGO, JR., M.D., ST. LOUIS, MISSOURI
AND FREDERICK J. FISCHER, M.D., DETROIT, MICHIGAN

Transplantation of the biceps femoris to replace a totally paralyzed or greatly weakened quadriceps femoris has been recognized for many years as a sound orthopaedic procedure. Numerous case reports have appeared in the literature but a thorough discussion of all phases of the procedure has not been found. It is therefore the purpose of this paper not only to present the end results in sixty-three cases, but also to discuss in detail the proper selection of cases, the operative technique, the post-operative care, and the complications that may ensue in transplanting the biceps femoris forward into the quadriceps-patellar-extension apparatus.

HISTORY

In reviewing the literature that has accumulated on muscle transplantation, Nicoladoni, in 1880, seems to have been the first to advocate transplantation of tendons. His first attempt consisted of transplanting the peroneus longus into the tendo achillis for relief of calcaneus deformity of the foot.

Goldthwait, in 1896, in an article on perneal transplant suggested the possibility of tendon transplantation about the knee.

However, as far as we have been able to determine, it was not until 1898 that transplantation of the biceps femoris tendon in conjunction with the semitendinosus was undertaken. Lange and Krause individually and simultaneously performed the operation for paralysis of the quadriceps femoris.

In Lange's two cases the transplanted tendons were sutured directly into the quadriceps tendons, and both were failures. In Krause's case the transplanted tendons were sutured directly into the patella and an excellent result was obtained. He attributed the result to mobilization of the tendons and muscles high up in the thigh and to direct insertion of the tendons into the substance of the patella.

Lange, in 1899, again transplanted the biceps femoris and semitendinosus, using his "periosteal method" of anchoring the tendons to the new insertion. A good result was obtained.

The first American to report a case of biceps femoris transplantation was Painter in 1902. The result in his case was excellent.

*From the Shriners' Hospital for Crippled Children, and the Department of Surgery of Washington University.

Numerous observers have reported cases since 1902 but only four of these articles analyze the results of large groups of cases.

Kleinberg, in 1917, reported twenty-three cases of hamstring transplants in infantile paralysis. Of this number thirteen biceps femoris transplants were reported. These cases all showed a substantial gain in voluntary extension of the knee against gravity. The knees were all stable and improvement in gait was noted.

In 1923, Colonna, in a series of seventy-eight biceps femoris transplants and twenty-three inner hamstring transplants, reported the end results of twenty-four cases. He stated that satisfactory functional results were the rule and that transplantation of the outer hamstring gave better results than transplantation of the inner hamstring muscles.

In the same year Seiffert reported twenty-nine biceps femoris transplants, twenty-six of which were done for quadriceps paralysis in chronic poliomyelitis. In most of the transplants he used the gracilis in addition to the biceps femoris, following the suggestion of Biesalski and Mayer that an inner hamstring muscle be combined with the outer hamstring. Seiffert followed his cases for many years and reported only three failures. Of these, two were attributed to weakness of the transplanted muscle before operation; the third was due to detachment of the transplanted biceps tendon from its new insertion.

Ritter, in 1928, analyzed the end results of thirty-five cases and reported no failures.

Hence it would seem that the procedure under discussion has, in the past, given highly satisfactory results in the hands of those who have advocated its use.

SELECTION OF CASES

As is true in any surgical procedure, the ultimate success of transplantation of the biceps femoris depends in no small degree upon the proper selection of cases. A thorough analysis of each individual case, not only from the standpoint of physical factors for and against the operation but also from the angle of intelligence and cooperation of the patient, will reduce to a minimum the number of failures and preclude the annoying complications which sometimes follow.

Paralysis or marked weakness of the quadriceps femoris associated with the presence of a strong biceps femoris does not *per se* warrant the operation. Certain patients in whom there is insufficient power to extend the knee learn to overcome a "quadriceps gait" by various means of substitution which give them a satisfactory functional gait, and hence they do not need the operation. Other patients in whom there is quadriceps femoris paralysis associated with a strong biceps femoris frequently have insufficient power in the hip muscles to permit walking without mechanical support, and certainly these cases should not be considered as eligible candidates for biceps femoris transplantation. One is never justified in

doing the operation unless there is reasonable hope that apparatus can be discarded at some future date.

In addition to adequate hip muscles, certain of the other muscle groups must be present before the supporting power of the biceps femoris can be removed from the posterior aspect of the knee joint. This is notably true of the gastrocnemius-soleus group which furnishes a powerful support to the back of the knee. If this muscle group is paralyzed or greatly weakened, removal of the biceps tendon is definitely contraindicated because genu recurvatum will invariably develop.

Hence, from the standpoint of muscle power, the ideal cases for biceps femoris transplant are those in which the hip muscles and the calf muscles are fairly strong and in which, because of extensor paralysis, walking is either unsightly, mechanically unsound, or impossible without supporting apparatus.

The presence of certain deformities contraindicates transplantation of the biceps femoris until these deformities have been entirely corrected. Flexion of the hip, flexion of the knee, genu valgum, and contracture of the tendo achillis are the four deformities which must be corrected before biceps femoris transplantation is done.

Flexion of the hip or flexion of the knee increases appreciably the distance between the origin of the biceps femoris and its new patellar insertion. Therefore, if the transplant is done first and the deformities corrected later, the transplanted muscle will be relaxed to such an extent that future contractions will have no effect on extension or stabilization of the knee.

If transplantation of the biceps femoris is done in the presence of genu valgum, subluxation or complete dislocation of the patella is likely to occur.

Shortening of the tendo achillis should likewise be corrected. This procedure may be done either before, at the same time, or after the biceps femoris transplant, but always before the patient begins weight-bearing.

In view of the extreme necessity of cooperation of both patient and parents in reeducating the transplanted muscle, there must be reasonable assurance that regular active physiotherapy will be religiously carried out over a period of at least a year or eighteen months. In several instances patients have left the hospital with strong, actively contracting transplants, but because of lack of cooperation at home they have returned with hardly sufficient power to move the patella. Our only total failure was in such a case.

OPERATIVE TECHNIQUE

The successful transference of the biceps femoris tendon from its fibular insertion forward into the quadriceps-patellar-extension apparatus of the knee depends largely upon proper operative technique. The operation can be more accurately described if considered as consisting of three distinct stages, — namely, preparation of the bed to receive the transplanted tendon, exposure and isolation of the biceps muscle, and the fixation of the

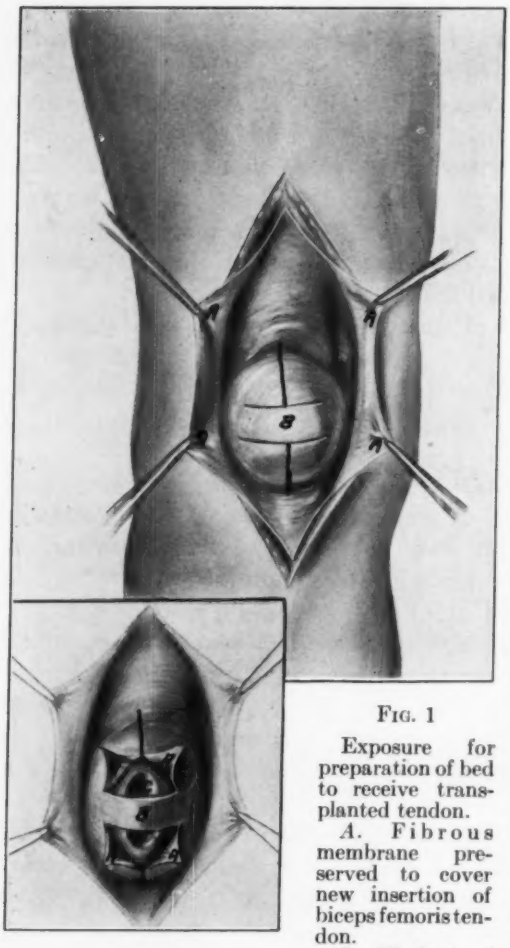

FIG. 1

Exposure for preparation of bed to receive transplanted tendon.

A. Fibrous membrane preserved to cover new insertion of biceps femoris tendon.

B. Method of cutting fibrocartilage covering of patella.

FIG .1-A

Detail sketch of prepared bed.

A. Flaps of fibrocartilage turned up.

B. Roof of fibrocartilage which covers transplanted tendon.

C. Trough in patella through which biceps femoris passes.

tendon to its patellar insertion.

In preparing a bed to receive the transplanted tendon an incision is made over the anterior aspect of the knee as shown in Figure 1.* After incising the skin and subcutaneous tissues, the quadriceps tendon, the patellar tendon, and the patella with its covering are exposed. Overlying the patella is a thin but tough fibrous membrane in which there are numerous anastomozing vessels. This membrane is incised longitudinally and dissected laterally and medially to the borders of the patella. It is important to preserve this membrane intact to form a covering over the transplanted tendon, preventing the skin and subcutaneous tissues from adhering to the patella. The fibrocartilaginous covering of the patella is incised as shown in Figure 1. The two parallel transverse incisions are joined within the substance of the bone, thus effecting a roof over the transplanted tendon (Fig. 1).

The four flaps shown in Figure 1-A are reflected from the patella. In the sagittal plane of the patella a trough is made within the substance of the bone to receive the transplanted tendon (Fig. 1-A). After the bed is prepared, the entire wound is temporarily closed with towel clamps and dressings.

The second stage of the operation is carried out as follows: An incision is made over the lateral aspect of the thigh beginning at the junction of the upper and middle thirds and extending downwards toward the knee joint

*We are deeply grateful to Mr. P. A. Conrath of the Department of Surgery, Washington University, for the drawings illustrating the technique of operation.

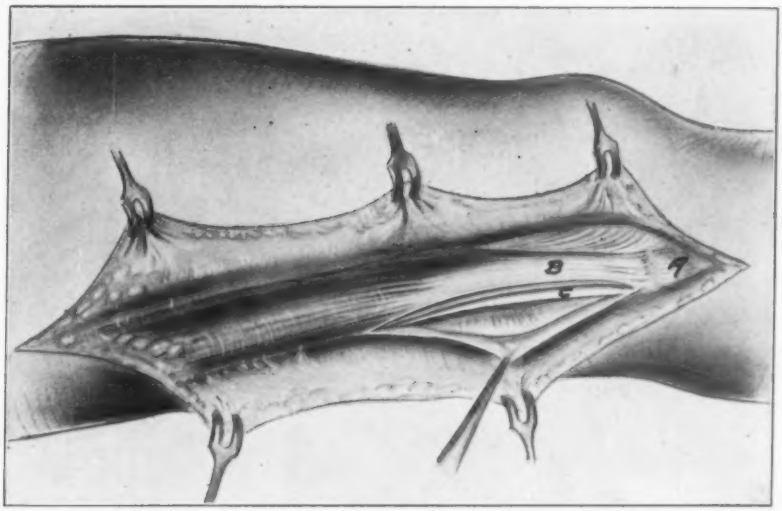

FIG. 2

Exposure of biceps femoris muscle and tendon.
A. Head of fibula.
B. Tendon of biceps femoris.
C. External popliteal nerve.

over the interval between the vastus lateralis and the biceps femoris. At the level of the knee joint the incision is curved backward and downward to a point one inch below the head of the fibula. The external popliteal nerve should be freed sufficiently to pass a moist tape around the nerve trunk so that it may be easily retracted out of the field of operation. After tracing the nerve to the point where it winds around the head of the fibula, the insertion of the biceps femoris can be safely removed without fear of nerve injury (Fig. 2).

The tendon, along with a portion of the head of the fibula, is freed with an osteotome. Unless due precautions are taken the fibular collateral ligament is likely to be severed as it lies firmly adherent to the biceps tendon at its point of insertion.

The biceps tendon is now dissected upward along with its muscle belly. This dissection should be carried as far up the thigh as the limit of the incision will allow. It is always necessary to cut the origin of the short head of the biceps femoris upward to the point of entrance of its nerve and blood supply. If this is not done the transplanted muscle and tendon will be forced to work around a curve and the efficiency will be correspondingly decreased. It can be dogmatically stated that the more oblique the pull the more efficient the transplant.

A subcutaneous tunnel is burrowed from the incision over the patella to the incision in the thigh. This tunnel should contain subcutaneous fat both on its roof and on its floor. It also should be sufficiently wide to permit free gliding of the muscle belly. The iliotibial band, along with the

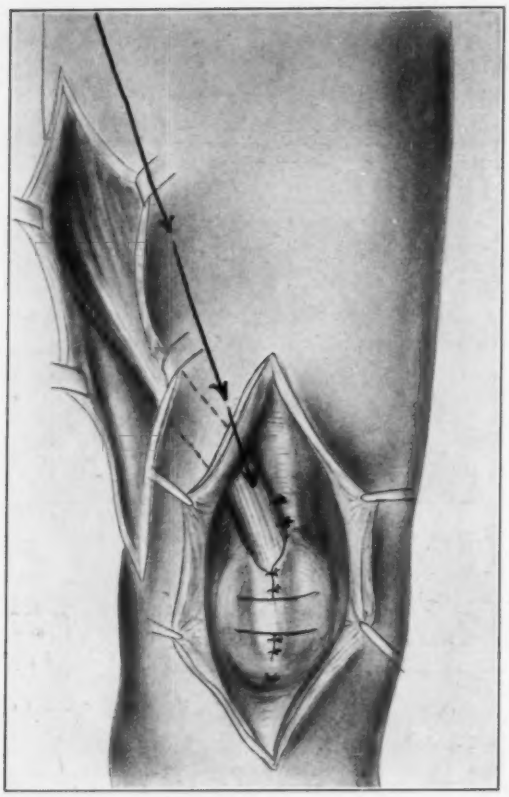

FIG. 3

Transplanted tendon fixed in place. The tendon as illustrated is pulling around too much of a curve due to lack of sufficient mobilization of muscle belly upward. Black arrows indicate proper line of pull.

fascia of the vastus lateralis and the external intermuscular septum, is divided at a point below the level of the passage of the transplanted muscle. This procedure further increases the obliquity of the pull of the transplanted muscle.

The biceps femoris tendon is passed through the subcutaneous tunnel into the previously prepared groove under the roof in the patella. It is essential that the hip and knee be placed in full extension because flexion of either of these joints causes an increase in the distance between the origin and the new insertion of the biceps tendon, and if the tendon is sutured in place with flexion of the knee or hip, future contractions of the muscle will only take up the slack and will not stabilize or extend the knee. For the same reason it is of great importance to suture the tendon in place with considerable downward pull on the tendon and upward push on the patella. The lower end of the tendon is anchored firmly into the ligamentum patella with a mattress suture of No. 1 chromic catgut. The four fibrocartilaginous flaps are folded over and sutured with the same material. In a similar manner the biceps tendon is firmly sutured to the quadriceps tendon (Fig. 3).

In closing the wound, the thin fibrous layer described above is sutured over the entire new insertion with a running stitch of plain No. 0 catgut. This procedure will prevent future adhesions of the skin and subcutaneous tissue to the bone. All wounds are carefully closed in layers with plain No. 0 catgut and silk. A plaster cast is applied from the groin to the toes with the knee and hip in full extension. *Postoperative elevation of the extremity to prevent swelling is effected by raising the foot of the bed and not by elevation of the extremity on pillows, as flexion of the hip would tend to place too much strain on the transplanted tendon.*

MUSCLE REEDUCATION

By far the most important factor in determining the success of the transplant is the stage of muscle reeducation. The success or failure of the transplant depends almost entirely upon persistent intelligent physiotherapy. In this respect we differ radically from the opinion voiced in previous articles and textbooks. It has been our experience that tendon inserted into bone is firmly healed in a maximum of twenty-eight days, and also that healing is sufficiently strong in twenty-one days to allow gentle contractions of the transplanted muscles without fear of detaching the newly formed insertion. Instead of waiting the conventional six to eight weeks before the institution of physiotherapy, we begin baking, massage, and active exercises after the end of the third week. The postoperative plaster is removed, the stitches taken out, and a new plaster applied from groin to toes inclusive. This second plaster is cut to permit maximum fixation and at the same time to allow adequate room for massage, baking, and exercises (Fig. 4).

On the first visit to the gymnasium the lid of the cast is removed and the area thus exposed is massaged and baked. The physiotherapist then teaches the patient how to actively contract the quadriceps and pull up the patella on the *normal* side. After this is learned, the patient is instructed to attempt the same procedure on the *transplanted* side. It is an error to encourage active contractions of the transplanted biceps by asking the patient to flex the knee. The muscle will undoubtedly contract if the patient endeavors to flex the knee, but the object of the operation is to convert a flexor into an exten-

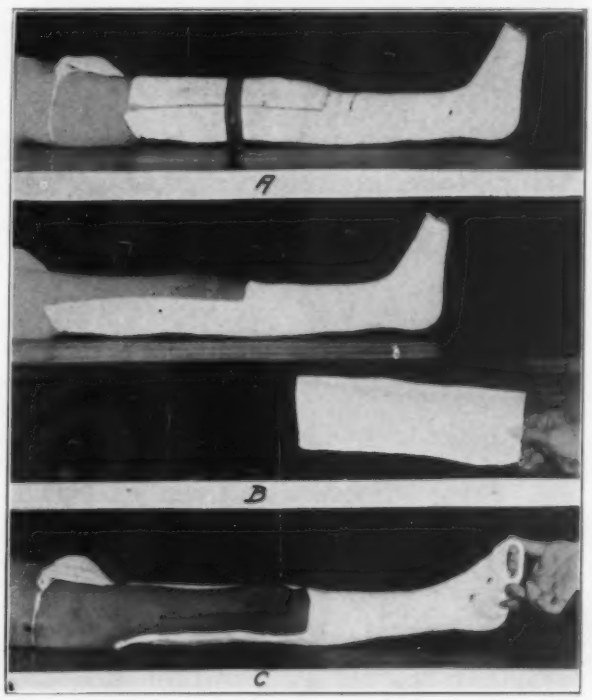

FIG. 4

Method of fixation after removal of sutures. Patella movement is started at end of third week.

A. Window fixed in place.

B. Window removed for massage, baking, and exercises.

C. Patellar incision at end of third week.

sor and actual dissociation can never be accomplished if the patient must continually attempt flexion in order to obtain extension. Hence, the importance of always keeping foremost in the patient's mind the fact that the patella must be pulled upward. Sooner or later the trick is learned, and once accomplished, subsequent contractions are easy. Some patients will learn to pull up the patella during the first gymnasium visit; others will require more time, but we have had only one patient who has failed to learn to move the knee cap with the transplanted muscle.

The baking, massage, and active exercises of the transplanted muscle in plaster continue daily from three to four weeks. At the end of this period the cast is bivalved to permit exercises in water. Active and passive flexion and extension of the knee are continued under water for a period of two to three weeks and finally table exercises against gravity are begun. Throughout this entire period the limb is protected by a bivalved cast.

When the transplant has gained sufficient strength, weight-bearing is gradually allowed. Some form of protective support should be worn for at least one year after operation. This support may be a thigh brace, a bivalved walking cast, a leather knee cage, or a celluloid mold.

At the time of discharge the patient and parents are given thorough instructions in home care and are impressed with the importance of daily exercises over a period of eighteen months or two years.

In our clinic we endeavor to check all the cases at intervals of from two to six months. It is a simple matter to judge whether or not the exercises have been neglected. Undoubtedly, in most cases, our poor results are with those patients from whom we have not had cooperation in the matter of exercises at home.

At the end of a year all support is removed, and at the end of eighteen months or two years intensive exercises are no longer necessary as the transplant will have gained the maximum amount of strength.

DISSOCIATION

In considering the question of dissociation of the hamstring muscles after transplantation of the biceps femoris, we do not intend to discuss or explain the physiological mechanism through which such dissociation takes place. However, we are certain of the fact that varying degrees of dissociation do occur. With the exception of one total failure, the transplanted biceps femoris has never failed to function as an extensor of the knee.

In a high percentage of cases there has been complete dissociation of the hamstring muscles. By complete dissociation we mean complete relaxation of the inner hamstrings when the knee is actively extended with the biceps femoris muscle, and complete relaxation of the biceps femoris muscle when the inner hamstrings are actively flexing the knee.

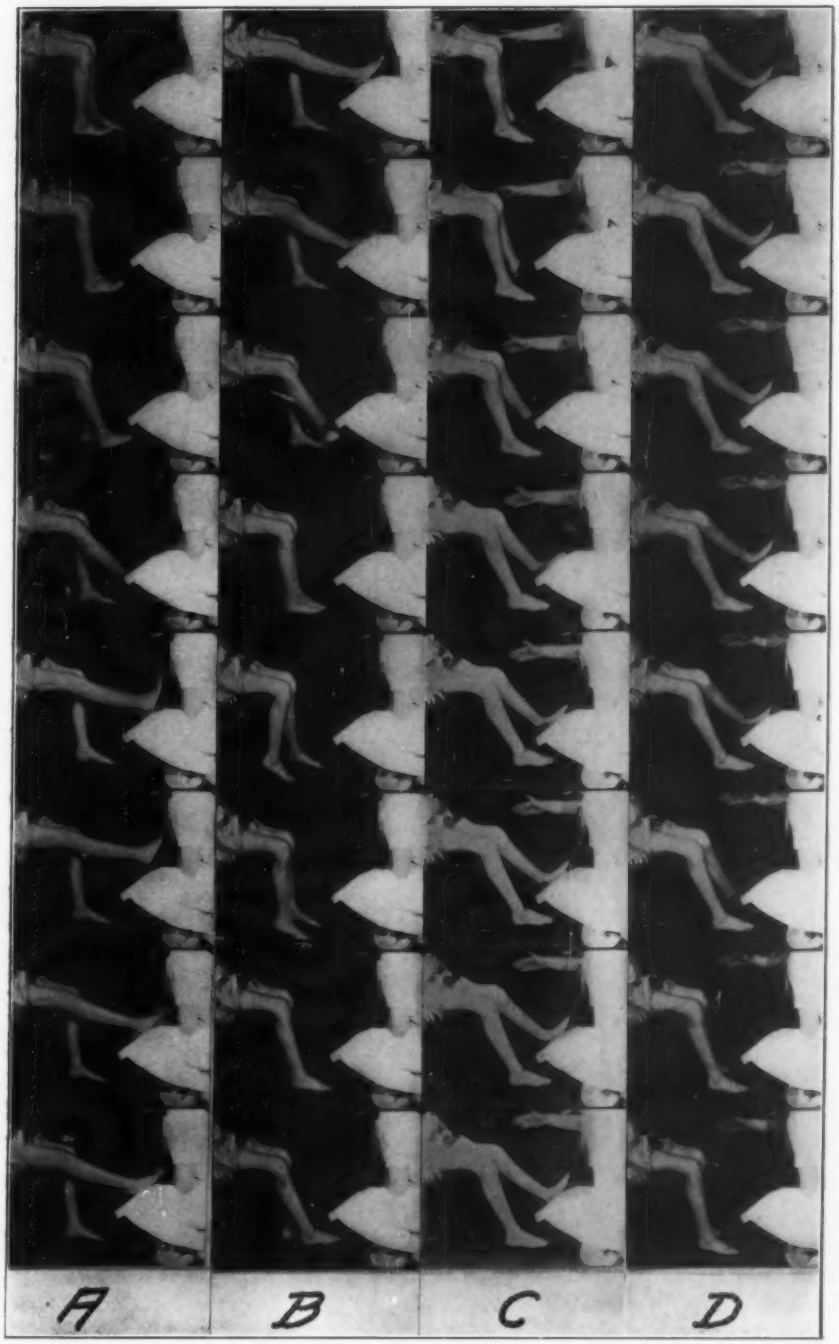

FIG. 5

V. S. Age eleven. Bilateral biceps femoris transplant for total paralysis of quadriceps femoris, residual poliomyelitis. No return in power of quadriceps femoris.

A. Full extension of the right knee with transplanted biceps femoris.

B. Same as *A* showing flexion.

C and *D*. Extension and flexion of left knee with only the power of the transplanted biceps femoris.

In other cases the inner hamstrings contract in varying degrees when the biceps femoris is actively extending the knee, but in active flexion the biceps femoris is relaxed.

In still another group the inner hamstrings remain relaxed when the biceps femoris actively extends the knee, but the biceps femoris contracts in varying degrees when the knee is actively flexed by the inner hamstrings.

Lately we have observed that, if exercises are directed toward dissociating the inner hamstrings by means of active flexion as vigorously as the exercises for converting the biceps femoris into an extensor, dissociation is more likely to be complete. In other words, we have in the past directed all of our efforts toward training the biceps femoris to extend the knee without considering the importance of educating the inner hamstrings to act alone.

It is our belief that complete dissociation will occur in a much higher percentage of cases if equal emphasis is placed upon the reeducation of both the inner and outer hamstrings instead of training only the transplanted muscle.

COMPLICATIONS AND CAUSES OF FAILURE

The most common complication arising from transplantation of the biceps femoris is back knee or genu recurvatum. This deformity results either from too little support to the back of the knee or from shortening of the tendo achillis. In cases resulting from the former the cause is usually weakness or paralysis of the gastrocnemius. After the support of the biceps femoris is removed, a weak gastrocnemius is unable to prevent hyperextension of the knee and genu recurvatum ensues. This complication will not occur if cases are properly selected, as the biceps femoris should never be transplanted unless there is a strong gastrocnemius-soleus group present. If the complication does arise it becomes necessary to relieve it. This is best done by prolonged fixation in a brace that prevents full extension of the knee and by the use of a plaster night splint which holds the knee in a position of fifteen degrees to twenty degrees flexion.

It would seem a paradox that shortening of the heel cord could cause the same deformity as paralysis of the gastrocnemius, but on closer analysis the explanation is simple. If the heel cord is contracted, the foot is held in varying degrees of plantar-flexion, depending on the severity of contracture. In normal walking the feet are alternately plantar-flexed and dorsiflexed. During the forward swing of the leg the foot is plantar-flexed and as the body moves forward over the extremity the foot gradually dorsiflexes. At the same time the knee moves from full extension to a slight degree of flexion. In other words, the foot is plantar-flexed and the knee fully extended when the lower extremity is at the forward position in walking. At the end of the step the foot is dorsiflexed and the knee slightly flexed. If then the foot is in a position of fixed plantar-flexion due to a short heel cord, it is impossible to dorsiflex as the body goes forward

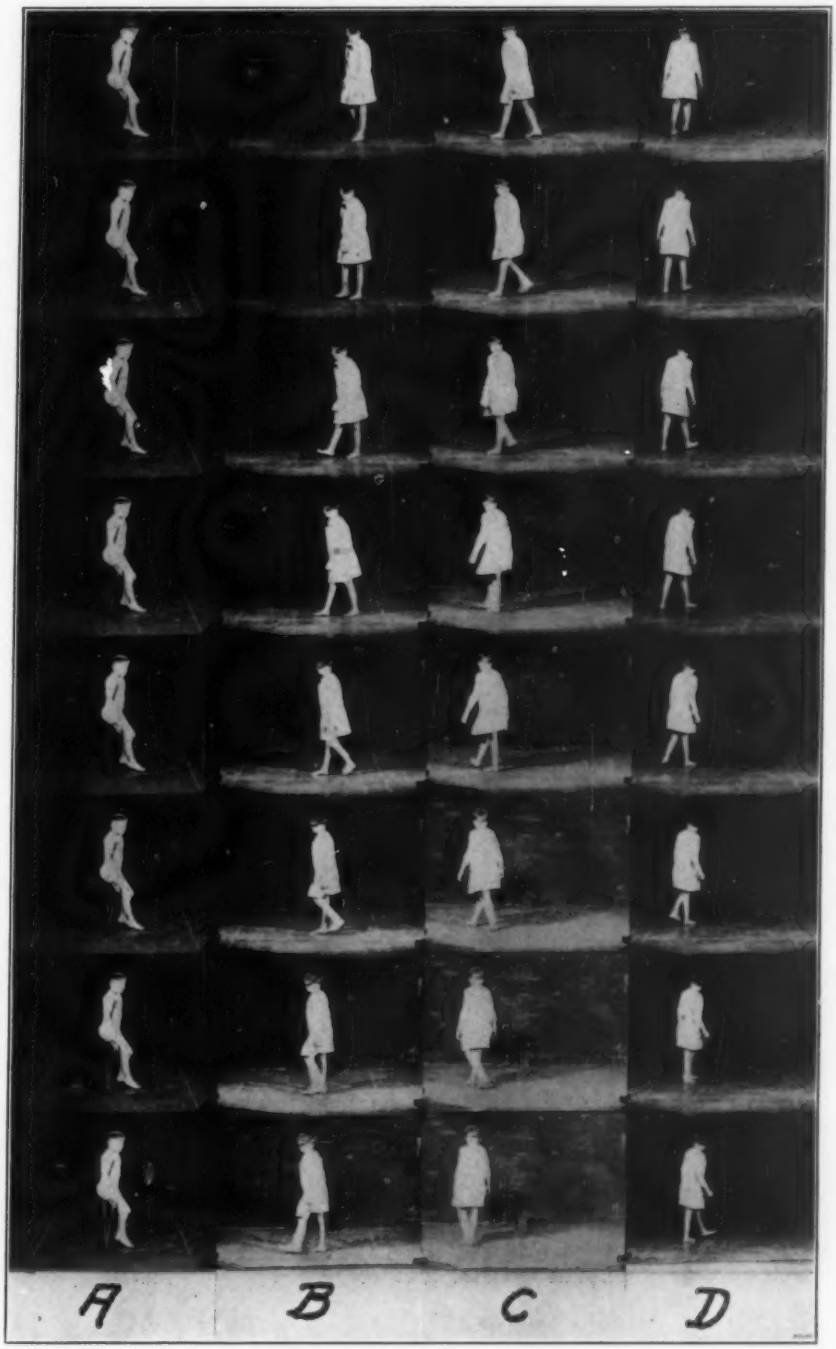

FIG. 6

V. S. Age eleven. Entered hospital because of deformities following poliomyelitis at age of three.

A. Condition on admission: 30 degrees flexion contractures of both hips; 25 degrees flexion contractures of both knees; total paralysis of each quadriceps femoris.

B, *C* and *D*. Patient's gait after straightening of hips and knees and bilateral transplantation of biceps femoris.

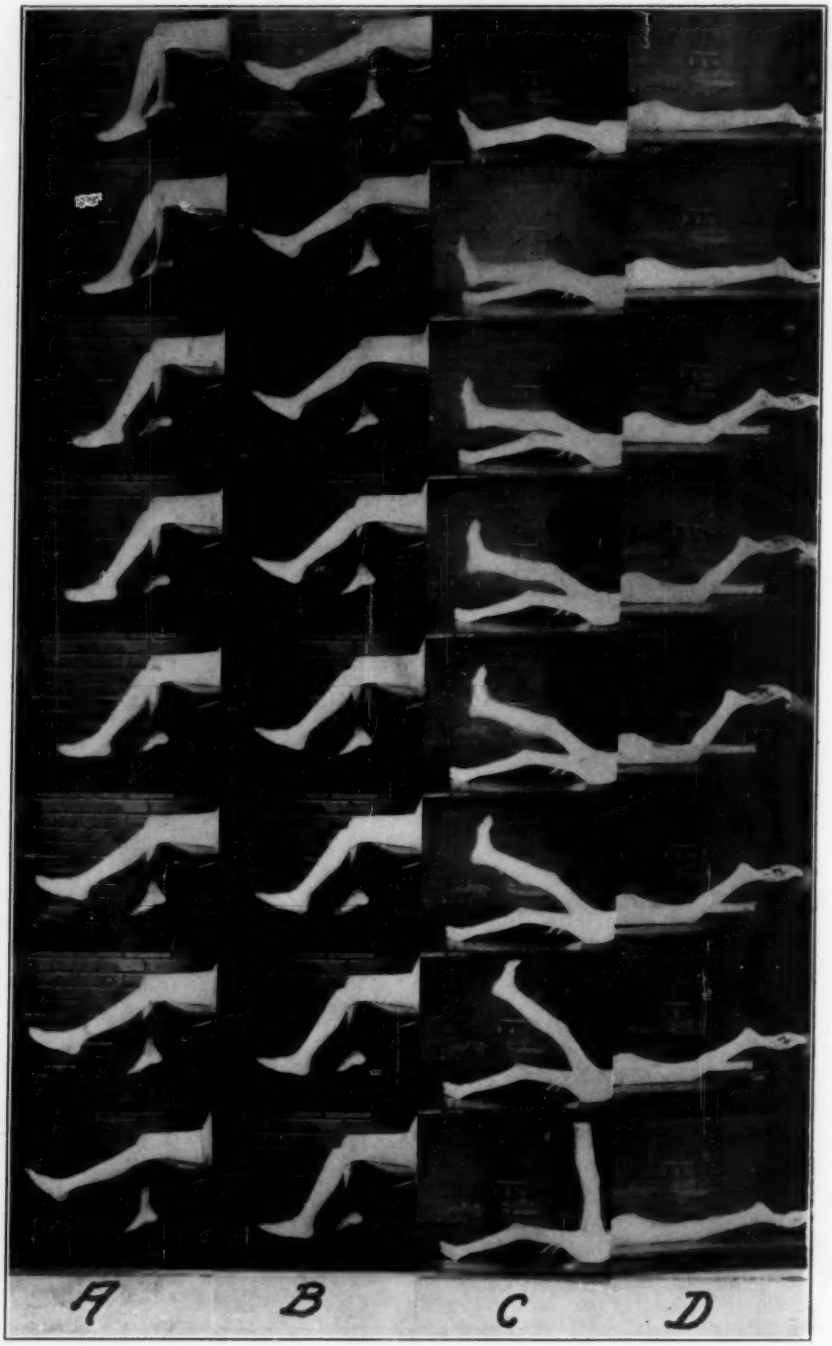

FIG. 7

M. K. Age twelve. Entered hospital for correction of deformities. Had poliomyelitis at age of six months. Total paralysis of left quadriceps femoris. Walked with crutches.

A and *B*. Complete excursion of extension and flexion of the left knee following biceps femoris transplant. Quadriceps still totally paralyzed.

C. Lifting the weight of the whole leg with the transplanted muscle.

D. Inner hamstrings completely dissociated.

over the affected extremity. Consequently, as the weight is shifted to the plantar-flexed foot the patient either comes up on his toes or tends to thrust his knee forcibly into hyperextension. If the sole of the foot is held to the floor, this forcible thrust causes the gradual development of genu recurvatum.

The correction of this deformity is lengthening of the heel cord. A word of warning, however, is not amiss at this juncture. In lengthening heel cords for recurvatum, care should be exercised to lengthen the heel cord just enough to allow the foot to dorsiflex very slightly beyond a right angle, for if too much length is added the recurvatum may still be present because of the lack of adequate support of the gastrocnemius.

A second complication is lateral subluxation of the patella. This subluxation may be only of slight degree and if so needs no treatment. Total dislocation does occur and the treatment of this is operative transference of the tibial tubercle to the inside of the tibia. This complication is entirely avoidable if due consideration of its possible occurrence is taken at the time of operation. When the biceps tendon is inserted into the quadriceps-patellar-extension apparatus, one should be careful to check the line of pull of the transplanted muscle. Any tendency to subluxation of the patella may be easily demonstrated and, if present, the tibial tubercle should be shifted inward to the point where it will be impossible for future subluxation to occur. Transplanting the tibial tubercle of necessity delays the advent of physiotherapy until about the seventh or eighth week postoperative.

CAUSES OF FAILURE

Although we have had only one total failure, and that failure due to entire lack of cooperation of both patient and parents, the following causes might well be listed as possible factors in failure:

1. Insufficient strength of the biceps femoris.
2. Lack of adequate fixation of the tendon to its new insertion.
3. Scar tissue binding down the muscle belly in the subcutaneous tunnel.
4. Insufficient mobilization of the tendon and muscle belly high up the thigh.
5. Improper selection of cases.

RESULTS

In analyzing our cases we have arbitrarily divided our end results into three groups, — excellent, good, and fair.

We consider as *excellent* results only those cases in which the transplanted muscle is sufficiently strong to completely extend the knee against gravity.

Those cases having sufficient power to extend the knee to 160 degrees against gravity have been classed as *good* results.

The *fair* results include those cases with sufficient strength to stabilize the knee without the use of external support.

The following table is a complete analysis of sixty-one of our sixty-three cases.

Period of Observation	*Three years and over*	*One to Three years*	*Six months*	*Total*
Excellent	16	14	8	38
Good	8	6	0	14
Fair	3	2	3	8
Failure	1			1
Total				61*

*Two cases never returned to clinic.

The youngest age at which the operation has been done was five years, the oldest was twenty-two years.

Of the sixty cases with satisfactory results, only three had power in the quadriceps at the time of operation. In six cases there were varying degrees of return in the power of the quadriceps. Thus in fifty-one cases the only means of active extension of the knee was the transplanted biceps femoris.

Five cases developed a genu recurvatum deformity, two due to short heel cord, two because of weakness of the gastrocnemius, and one from a combination of these two causes. These complications were overcome by treatment.

Two cases developed subluxation of the patella which required transference of the tibial tubercle to the inner aspect of the tibia.

CONCLUSIONS

I. In a series of sixty-three cases, transplantation of the biceps femoris forward to replace or to reenforce the quadriceps femoris was found to be a highly satisfactory procedure.

II. The operation should not be done in the presence of deformity of the knee or hip, in the absence of sufficient posterior support of the knee, or unless there is reasonable hope that mechanical support can be discarded.

III. The essential points to be observed in a well executed operation are:

1. Preparation of an adequate patellar bed into which the tendon is to be inserted.
2. Sufficient freeing of the biceps femoris muscle upward to insure the maximum obliquity of pull.
3. Suturing the tendon firmly to its new insertion under tension and with the knee and hip in full extension.

IV. The stage of muscle reeducation determines to a great degree the success or failure of the transplant. The important points to be remembered are:

1. Early institution of exercises, baking, and massage (third or fourth week).
2. Mechanical support of the transplant for at least a year.
3. Faithful daily exercises over a period of at least twelve to eighteen months directed at both extension and flexion of knee.

V. Complications and failures are for the most part avoidable if the cases are properly selected and the treatment properly carried out.

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PROXIMAL OSTEOSYNTHESIS IN INTRACAPSULAR FRACTURE OF THE HIP

An Experimental Study

BY MYRON O. HENRY, M.D., MINNEAPOLIS, MINNESOTA

Mr. E. W. Hey Groves[1] presented a method of attack on *fresh* unimpacted fractures of the hip in 1929, and stated that he was "strongly in favor of the open pegging operation in certain selected cases", believing that closed methods fail in a certain proportion of cases. He introduced "*proximal pegging*" (Fig. 1) done by opening the hip joint, dislocating the head, and fitting it accurately to the neck with a beef-bone peg; and he reported some excellent results secured in this manner. His procedure is obviously correct mechanically, and should prove superior to any form of blind pegging from the distal side. The logic and soundness of Hey Groves' method fascinated the writer and he determined to check the merits of the operation and its end results by animal experimentation.

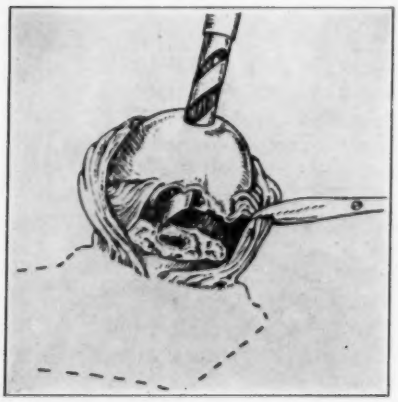

FIG 1-A

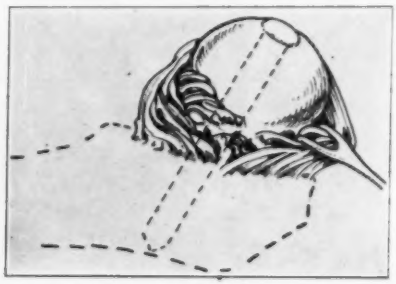

FIG 1-B

Hey Groves' proximal pegging operation. (*The Journal of Bone and Joint Surgery*, XII, 1, 1930.)

Fifteen proximal osteosyntheses were done on dogs. The animals used were obviously not young, and while their exact ages were unknown, their epiphyseal lines were no longer discernible by x-ray. The introduction of a nail or screw from the proximal side, according to the Hey Groves' method, necessitates severing the ligamentum teres in the dog, in order to dislocate the proximal fragment for pegging. Since the ligamentum teres is the only soft-part attachment for blood supply to the head, in *true* unimpacted intracapsular fracture of the hip, this procedure enabled study of the fate of the head devoid of all soft-part attachments.

No cooperation from the patient could be expected in animal experimentation of this kind; so a strong material was required for internal fixation. Gold, aluminum, and stellite were shown by Zierold[2] to be almost

inert in bone, but the successful use of rustless steel by Böhler and others made this metal seem more practical. Nails of the proper size were made of rustless steel and used in three of these proximal pegging experiments, but without external immobilization they failed to hold in each case, and nails were therefore discarded as a means of adequate fixation of the fragments. The author believes the round nail is inadequate for this purpose.

A rustless steel screw was then devised by the writer, and made from heavy Böhler nails of rustless steel. Screws were machined of this material, having coarse, double-pitched threads, and they were tapered slightly at each end to a head with a slot. They were then highly polished, which enhances the inherent properties of the steel to be inert in bone. Such a double-headed screw is introduced *proximally*, through a drill hole *the size of its core* in the head and neck, and can be removed later from the trochanteric side.

The spongiosa is densest toward the proximal side of the femoral head of the dog, as it is in man. It becomes less dense along the axis of the neck, and no compact bone is encountered until the trochanter or cortex of the shaft is reached. A suitable device for internal fixation must therefore be long enough to bite well into the denser spongiosa of the proximal side of the head and simultaneously grasp the cortex of the shaft or trochanter (Fig. 2). This is important.

FIG. 2

Rustless steel screw, double-headed. Actual size. (Used in dogs.)

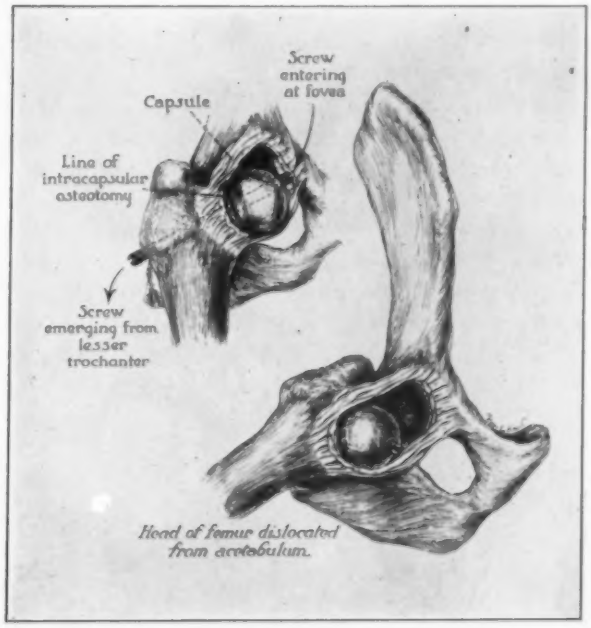
Screw entering at fovea
Capsule
Line of intracapsular osteotomy
Screw emerging from lesser trochanter
Head of femur dislocated from acetabulum.

FIG. 3

Proximal osteosynthesis with rustless steel screw. Screws not yet driven home or countersunk.

In these experiments the dogs were carefully bathed twenty-four hours before operation to free them of parasites. Ether anaesthesia was used in

all cases with the customary administration of morphin. The entire hip region was clipped free of hair, shaved, scrubbed with soap and water, and iodized as usual. The Smith-Petersen incision was used in only two cases, because it was found that the replaced muscle origins pulled loose from their suture line in spots along the iliac crest when immediate activity was permitted, thus producing troublesome muscle atrophy. A straight anterolateral incision from the anterior superior iliac spine to a point a little below the trochanter, was found most serviceable. By this means the hip was exposed by blunt dissection *between* the muscles, it being necessary to cut only one tendon (the quadratus femoris) which was later easily sutured. The ligamentum teres was cut in order to dislocate the head. A drill hole was made through the head, neck, and trochanter, entering at the fovea capitis femoris and emerging through the trochanter laterally. Next, a complete transverse osteotomy of the neck was done intracapsularly, proximal to the attachment of the reflected fibers of the capsule, with a chisel. The rustless steel screw described above was then introduced, firmly fixing the head to the neck. Accurate apposition of the osteotomized surfaces was obtained in this manner in eleven proximal screw experiments of this series (Fig. 3). The wound was closed in the usual manner, using plain catgut for the capsule, chromic catgut for the repair of the abductor tendon, the muscles, and the fascia, and linen for the skin. Mastisol dressings were employed, which made healing possible by first intention in dogs having no external immobilization.

Imperfect immobilization is generally considered a prolific cause of non-union, though Bankart[3] has reminded us that few fractures of the ribs, which are almost constantly in motion, fail to unite. In these experiments all animals immobilized in plaster-of-Paris died. Therefore external immobilization was discontinued and in the successful operations in this series no external splinting was employed. The modern trend seems to be away from prolonged immobilization in the treatment of fractures near joints. Early active motion is thought to stimulate healing by maintaining normal circulation and preventing atrophy of disuse. The efforts of Basset[4], Böhler[5], Henderson[6] who did the first proximal pegging operation for non-union, Hey Groves[1], Lambotte[7], and Smith-Petersen[8] have all been toward this end.

Without external immobilization the animals were usually found getting about with stable hips a day or so after operation. A little stiffness was present for a few days, but, as no muscles were damaged by the operation, and no muscular atrophy appeared, use of the leg was usually normal before the skin had healed. A dog, having four legs, can be ambulatory with three, and consequently *will* not use a painful or unstable extremity at all. As operative technique was perfected, less damage to soft tissue occurred, and some animals used the operated leg as early as forty-eight and even twenty-four hours after operation. The screw must be carefully countersunk into the articular side of the proximal fragment. Otherwise it may cause traumatic arthritis, such as developed in one of these cases.

The writer is satisfied that a proper rustless steel screw, accurately introduced from the proximal side and biting into firm bone of the distal or trochanteric side, furnishes adequate mechanical apposition and fixation of the fragments in unimpacted intracapsular fracture of the hip of the dog without external immobilization of any sort.

But what of the fate of the head devoid of all soft-part attachments? Does it remain alive, or pass through a stage of aseptic necrosis revivifying by "creeping substitution" as explained by Phemister[9]? Certainly the blood supply is of importance in considering the further fate of the head. In a *true* unimpacted intracapsular fracture of the hip, there is no soft-part attachment to the head except the ligamentum teres, and considerable difference of opinion exists as to the value of the blood vessels contained in this structure in adult life for nutrition of the head. By a series of microscopic sections, Schmorl[10] has shown that "the vessels of the round ligament are active even in old age"; and Phemister has shown that the head can be revascularized by "ingrowth of tissue from the round ligament and sometimes from adhesions". Santos[11] believes that "the vessels contained in the ligamentum teres at the time of fracture determine its subsequent vitality; if the vessels are adequate, the head remains alive; but if the vessels are inadequate, it undergoes necrosis". But he reports a case in which he encountered a spurting vessel in the ligamentum teres when excising a necrotic head.

Hey Groves, on the other hand, stated that in non-union attempts to preserve the head are useless "if it has no other soft-part attachments than the ligamentum teres". Albee[12] recognized this fact long ago when he did the first bone-graft peg for ununited fracture of the hip in 1913. He stated that the blood supply of the capital fragment was solely through the round ligament, and he believed this blood supply "inadequate for normal vitality, much less osteogenesis and union".

FIG. 4

Specimen Dog No. 44, 103 days postoperative. Bony union apparent but partially revivified head.

Osteogenesis progresses in proportion to

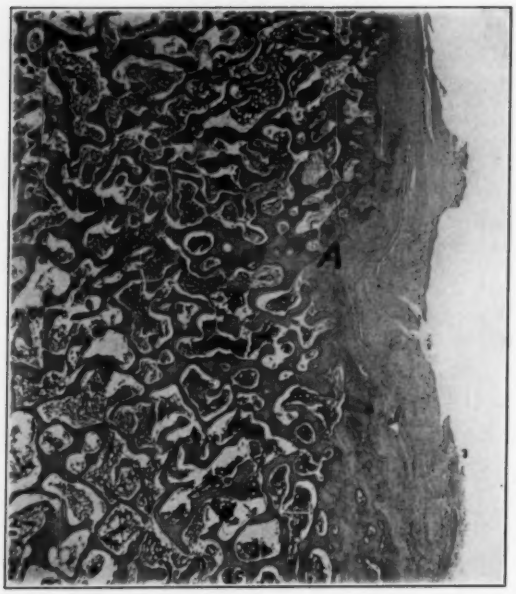

FIG. 5

Section through line of osteotomy, Dog. No. 64, 92 days postoperative.

A. Only remaining sign of line of osteotomy, slight indentation of connective tissue, few necrotic trabeculae in tiny area at margin of neck. Reduced from magnification of × 12.

the flow of blood toward the fracture zone in any fracture. This is one of the basic principles of Böhler's work, and is the underlying principle of the work of Smith-Petersen, Basset, Lambotte, and others. Phemister also believes that "functional stimulation plays an important part in the rate and degree of transformation into new bone". Bankart adds one more suggestion, — that there is an absence of stimulus to healing in intracapsular fractures of the hip, due to insufficient hemorrhage.

In these experiments seven animals have had useful hips a few days after operation. Active weight-bearing and use have not interfered with osteogenesis sufficiently to prevent good function in seven experiments. Firm bony union was demonstrable by x-ray as early as forty-nine days postoperative, and this was later verified by macroscopic examination of the specimen after removal of the screw. Areas of necrosis, interpreted as incomplete revivification of the head, appeared in only one case (Fig. 4). The earliest specimen was removed ninety-three days after operation, and, on sectioning the head and neck, the line of osteotomy was no longer apparent. Microscopic sections of the head and neck, taken along the axis of the neck through the line of osteotomy, showed normal bony trabeculae, with marrow of normal vascularity (Fig. 5). No evidence of necrosis of trabeculae was found throughout the section. The screw hole, however, was lined with a connective-tissue membrane, in which a few leucocytes were found, suggesting that even this rustless steel causes some slight irritation. The cartilage covering the head was entirely normal; but at the margin where the osteotomy was done there was some fibrous tissue covering the cartilage cells. In one case where traumatic arthritis developed, due to insufficient countersinking of the screw on the proximal side, areas of bone devoid of cartilage appeared on the head.

In the presence of sepsis, however, the head dies. Secondary infection occurred fourteen days after operation in one of these experiments. Absolute non-union and septic necrosis of the head were present in this case twenty-one days after operation.

The early and continuous good function obtained in the seven successful experiments seems to verify Murray's[15] explanation of the process of bone repair. Murray believes that death of tissue is essential to healing of a fracture, and that by death of tissue certain ferments are set free or activated which liberate calcium in adjacent tissues. There is a paucity of these ferments in intracapsular fracture of the hip; *only* those ferments resulting from the actual death of bone cells being available, as all others are necessarily excluded by the capsule. Murray says: "The calcium source for calcification is local and is the dead bone at the site of the fracture autolyzed by ferments set free or activated by tissue death and held *in situ* by the affinity of the fibrin of granulation tissue, and deposited in that granulation tissue to form bone by another ferment activity. The vital process is ferment activity in the presence of local calcium source, and the completeness or failure of the process depends upon the local $_{p}H$ of the tissue fluids induced by the local circulatory status. Vascular changes probably induce local $_{p}H$ changes which may strongly influence precipitation of calcium salts. Bone and soft-part circulation are of prime importance in the process of calcification of fracture healing."

Immediate and continuous contact of living bone with the osteotomized head devoid of soft-part attachments was gained in these experiments by the proximal osteosynthesis and use of the rustless steel screw. This firm contact, shown by Phemister to be important in the healing of fractures, is of paramount importance in intracapsular fracture of the hip, to prevent dilution of ferments, and change of $_{p}H$ content by synovial fluid. Albee and others have long recognized that synovial fluid retards callus formation. Close bony contact, such as was gained in these experiments by the proximal osteosynthesis and internal fixation with the rustless steel screw, enables the early granulation tissue to seal out the undesirable synovial fluid diluent from the zone of healing.

"Bone and soft-part circulation are of prime importance in the process of calcification of fracture healing", according to Murray, and "should be the prime objects of attention *early in the healing process*". By proximal osteosynthesis, this all-important requirement was met by active use within a few days of operation in these seven successful experiments.

The absence of soft parts about intracapsular fractures of the hip undoubtedly retards the healing process by liberating less of the stimulating ferments activated or set free by tissue death. The injection of blood into the fracture site, as done by Bankart, is a step in the right direction. Still better, however, as a stimulus to osteogenesis might be the application of a layer of excised muscle tissue, or fibrin from the blood, to the fracture line at the operation of proximal osteosynthesis.

The cooperation of the patient toward active motion without weight-bearing, can be secured in man; and in human hips perhaps an autogenous bone screw would have sufficient strength. Such an autogenous bone screw for proximal osteosynthesis offers obvious advantages, furnishing dead tissue and local calcium simultaneously with adequate mechanical fixation. The construction of an autogenous bone screw at operation,

however, presents additional problems, while a suitable screw of rustless steel can always be available.

The writer believes that there is a place for proximal osteosynthesis in certain selected cases in well equipped hospitals by an especially trained personnel.

CONCLUSIONS

1. Hey Groves' method of proximal osteosynthesis was performed in fifteen experiments on dogs. It was found that round nails were inadequate for fixation of the fragments of intracapsular osteotomy of the neck of the femur without external fixation.

2. Satisfactory contact and adequate fixation of the fragments of intracapsular osteotomy of the neck of the femur in dogs was obtained by a rustless steel screw of a special pattern which was practically inert in bone.

3. Early functional stimulation of the circulation is of prime importance in the healing process of intracapsular fracture of the hip.

4. Early, continuous, and accurate contact, with absolute fixation of the fractured surfaces, is of paramount importance in the healing of fractures in the presence of synovial fluid.

5. The capital fragment, devoid of all soft parts, in intracapsular osteotomy of the neck of the femur of the dog, readily unites and revivifies under the proper physiological conditions essential to the healing process in bone.

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THE ORR TREATMENT OF OSTEOMYELITIS AND ALLIED SUPPURATIVE PROCESSES

A Statistical Analysis and Discussion of 155 Cases*

BY JACOB KULOWSKI, M.D., IOWA CITY, IOWA

This is a study of 130 cases of osteomyelitis, sixteen cases of suppurative arthritis, and nine cases of extensive soft-tissue suppuration, treated by the Orr method.

It is interesting to note that in the first case of osteomyelitis treated by this method in this clinic, the treatment was initiated at the personal suggestion of Dr. Orr, in 1923. This was a private case of Dr. Steindler's, one in which a postoperative infection occurred, following a corrective procedure for claw-foot, due to low focal resistance incident to an enormous spina bifida occulta. Several operations by the antiseptic method had resulted in failure. After the institution of Orr drainage, a rapid healing of the wound took place. Since that time the Orr method has been employed routinely in all cases of osteomyelitis, and has been gradually extended to other suppurative processes. The universal application of this plan of treatment has been amply justified by the end results obtained.

The source of this study is in part from the private practice of Dr. Steindler, the rest being indigent state and clinical patients. The operations were performed by Dr. Steindler and other members of the staff. This method solved the problem of transporting the patients to and from the clinic, reduced the postoperative care to several outpatient clinic visits, and minimized the expense to both state and individual.

A study of the literature definitely points to a world-wide adoption of the Orr method in the treatment of chronic osteomyelitis. Henry, Johnson, Hey Groves, Albee, Kleinberg, Chu, and Kreuscher and Huepper report favorably on this method. Experimental evidence clearly demonstrates the rationale of every step in the technique, which is based on sound surgical and pathological principles.

The essentials of the Orr method embrace the principles of adequate drainage and adequate immobilization until the wound has completely healed. There is only one primary operation because no distinction is made between the acute and chronic stages of the disease.

The Orr method is neither radical nor conservative. Both elements are harmoniously blended. The amount of bone surgery indicated depends entirely upon the extent of the destruction present and the general condition of the patient. The seemingly initial radicalism is entirely compensated by the absolute postoperative conservatism.

*From the Department of Orthopaedic Surgery, Service of Dr. Arthur Steindler, State University of Iowa.

There are several fundamentals of the technique which must be emphasized in order to obtain uniformly the best end results:

1. *Make a fairly large incision, and spread the soft tissues only far enough to afford access to the diseased area.*

A generous incision will allow healing to proceed from the bottom, without permitting premature closure of the soft parts. Soft-tissue wound enlargement was required in several cases of the reoperated group. Incisions made the entire length of the limb are sometimes indicated. The resultant scars do not necessarily interfere with function later. If old sinuses and scarred areas are present it is wise to excise them in order to establish a subsequent healthy basis for the growth of granulations. An approach to the diseased area through a thick layer of soft tissue also insures abundant granulations. The pressure of such adequate overlying tissues exerts a beneficial stimulating influence upon the bony granulations. It is obvious that the needless incising of healthy tissue should be avoided unless such tissue interferes with a direct approach to the bone. Drainage will be facilitated by placing incisions in the dependent parts, in order to employ the aid of gravity. Occasionally an extensive fascial-plane dissection by back pressure of accumulated pus may result if this point has not been duly considered. This is especially apt to follow if for any reason the limb requires elevation over a prolonged period. However, an adequate drainage procedure will insure sufficient evacuation of purulent material, no matter where it is located.

2. *Saucerize and remove all diseased necrotic bone.*

The question of how much bone to remove is a difficult one to answer, because the gross pathological picture is inconclusive, especially early in the disease.

Following exposure of the area as indicated clinically, an adequate sculptured window in the bone will insure proper drainage. If there is evidence of demarcation, it is important to remove a layer of the contiguous healthy bone. This also promotes the formation of an excellent bed for the subsequent granulations which are necessary to fill in and heal the wound. By shallowing or saucerizing the cavity, all overhanging ledges, which might hinder drainage, are obliterated.

Orr*, at present, does not insist upon saucerization as long as an adequate bony opening is made. The fact that small sequestra, which usually form from any remaining spicules, are so easily extruded does make this nicety of the technique seem unnecessary; but, unless there is much need for hurry, the observance of this detail will more likely insure an adequate opening for proper subsequent drainage. Curetting should be done gently, if at all, so as not to damage reparative processes. Reparative processes were not often noted in our series of cases, which were of long duration and battle-scarred from previous operations. The warning to be as gentle as possible serves to lessen any tendency to shock-producing procedures.

*Personal communication.

3. *Dry the cavity thoroughly; use tincture of iodin and alcohol.*

Antiseptics play absolutely no other part in the treatment. It is here used only in the listerian sense,—to exclude possible secondary contamination at the time of operation. Dr. Orr is emphatic in his renunciation of the antiseptic method of the treatment of wounds. Albee excludes the use of an antiseptic even in this stage of the treatment, on the assumption that it has an injurious effect upon the tissues and may interfere with the development of the bacteriophage. The writer is not aware that Orr has abandoned this detail, and feels that the antiseptic, so judiciously used, will control any lurking limited secondary bacterial invasion at the time of operation.

It is most important to dry the cavity as thoroughly as possible. Any remaining stagnant blood pool furnishes a perfect culture medium. Hot gauze packs will control practically all hemorrhage if sufficient time is taken. Various drying devices may be utilized to advantage. The antiseptic, also, has some hemostatic qualities.

4. *Pack wide open, but not tightly, with vaselin gauze.*

Adequate pressure from this non-irritating pack keeps the wound open without repressing the growth of granulations. Todd, in 1920, stated that too much pressure on bone retarded growth. The vaselin pack is the most satisfactory way of keeping the wound open, while at the same time exerting an optimum pressure. One must not get the impression that the pack causes any retention of pus; it acts merely as a "buffer". On the contrary the drainage is very profuse, especially at the time of the first inspection.

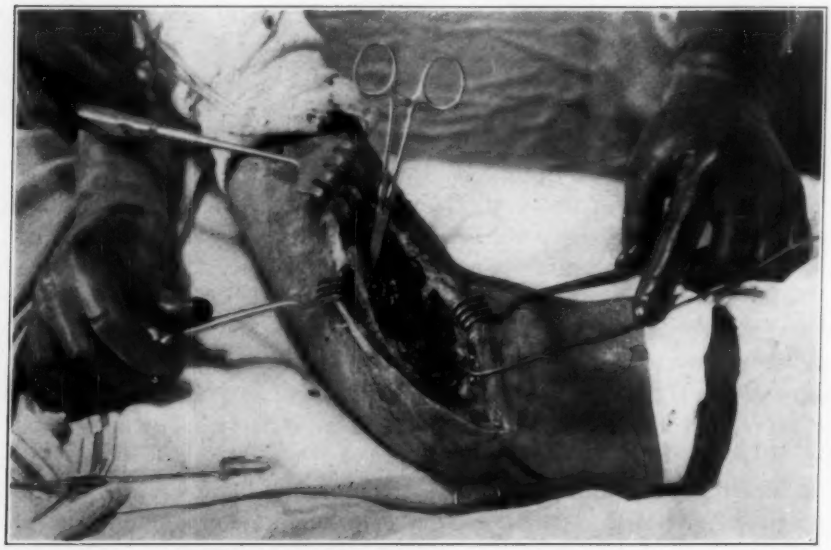

FIG. 1

The operative wound and bone bed prepared for the insertion of the vaselin pack. The skin exposure allows no undermining; the bone is saucerized. All bleeding has stopped. The wound is now ready for the pack.

FIG. 2

The vaselin pack lightly inserted. A generous dressing follows, and a cast will be applied which will immobilize the joint above and below the lesion.

Care must be taken to lay the vaselin gauze into the wound lightly. In this way there is no danger of exerting too much pressure on the growing granulations which tend to gradually extrude the pack. The chance of the gauze becoming adherent is negligible. It also prevents the frequent occurrence of skin excoriation. In our experience, skin irritation was a rare occurrence. When it is present, it is usually mild and yields promptly to treatment. Extra vaselin strips along the edges of the wound will, as a rule, prevent any marked maceration. The tendency is for it to recur in the same individual. In several instances where the chafing was more or less marked, one or two days out of plaster was sufficient to clear it up.

5. *Place the limb in the neutral position.*

Absolute physiological rest is thus obtained. This position serves to eliminate subsequent deformities; healing also is facilitated. In some cases this ideal could not be attained, and the healing time in these was prolonged. A wedge resection was recently done in an old tarsal infection with no untoward complications. As a rule, where the realignment requires bone work, it must be left entirely to the judgment of the operator.* It seems that if the saucerization can be tolerated, a resection or osteotomy in the same vicinity should do no harm. Orr sometimes operates through a window in the cast on those patients who are extremely ill, to minimize the postoperative handling of the parts.

6. *Immobilize in plaster cast.*

There should be no half-way measures about proper retention of the affected part. A cast is the best means of gaining this end. The joints

*Personal communication. Orr does not hesitate to do osteotomies if necessary at the time of the primary drainage operations.

TABLE I

GENERAL STATISTICAL TABULATION — OSTEOMYELITIS

Total number of cases	130
Males	101
Females	29
Age incidence	
Average	20.34 years
Extremes	3 months — 67 years
Mode of onset	
Sudden	63
Traumatic	50
Unknown	61
Insidious	6
Period of hospitalization	
Healed group	24.30 days — average
Unhealed group	36.34 days — average
Average total	30.32 days
Duration of disease	
Acute to 30 years' duration	
13 over 5 years' duration	
Average duration	3.93 years
Postoperative period of observation	
Healed group average	19 months
Unhealed group average	8.6 months
10 under 6 months	
7 under 1 year	

above and below the lesion must be fixed. Recently some of our refractory cases, with involvement of the lower end of the femur, were greatly improved by including the hip joint in the cast, plus the cessation of weight-bearing. The patients who are hardest to convince regarding adequate plaster immobilization are those with involvement of the lower end of the femur. They will not submit to a hip spica when apparently only the knee is involved. Osteomyelitis of the lower end of the femur is therefore not more formidable than other types, when adequate immobilization is secured. It has been a common observation that the lesions in the middle of the long bones heal in the shortest period. Orr is very emphatic about the importance of absolute rest, and feels that it is the prime factor in bringing about rapid healing of the wound.

Immobilization and rest does not cease with the healing of the wound. It must be continued persistently until functional stimulus has produced the proper architectural reaction in the bone. Braces should be worn for six months to a year after the wound has healed. If this point is borne in mind, recurrences will be minimized.

The primary cast may remain undisturbed for a period of from one to two months. The only indications for postoperative inspection of the wound are pain and temperature. Usually the patient pays little or no attention to the odor. It is to prevent secondary infection that the infrequency of dressings is urged.

No antiseptics are used postoperatively. The vaselin pack will gradually extrude itself as a rule. Small sequestra will be extruded during the course of healing, as has been mentioned above. This is another great advantage of wide-open drainage.

The question of ankylosis should not concern us greatly. Casts may produce temporary stiffness, but if the joint has not been involved, recovery takes place. When the joint has been destroyed, ankylosis is beneficial as it is in joint tuberculosis. Albee states that stiffness and atrophy are more likely to be caused by pain and muscle spasm than by this form of immobilization. Very little functional disability resulted directly from the cast. Active use invariably resulted in good movement of the joints unless there was excessive destruction present. The results obtained from the cases of suppurative arthritis dispel another unfounded criticism of the Orr method.

EXPLANATION OF TABLE I

There is little to add to the above tabulation. Foci of infection could not be satisfactorily demonstrated from the case records. It is difficult to determine the relationship the trauma bore to the onset of the condition except in those cases of compound fractures. Seventeen cases had a hospitalization period of less than one week; twenty-four of less than two weeks; three of less than three weeks; six of less than four weeks; and the others in the healed group a period of over a month. Note that over half of the unhealed cases are still too recent to judge definitely the final outcome.

Other factors, aside from the disease itself, have prolonged the hospitalization period. It sometimes requires several weeks to make the social service arrangements for the escorted transportation of some of the indigent patients after the indication for discharge has been made. Some of the patients remained on the ward because of unsuitable home conditions. Many other motives, commonly arising in a charitable institution, played their parts. Another important cause of the long hospitalization period, as recorded here, is that during the winter months there is a considerable incidence of infectious diseases among the hospitalized children. The periods of isolation do much to extend the postoperative stay in the hospital. In the majority of cases the patient's discharge was indicated several days after operation.

Most of our cases were of considerable duration and had had some form of previous drainage. There were enough comparatively acute cases treated to prove Orr's contention that every patient should be operated upon as soon as the diagnosis is made.

EXPLANATION OF TABLE II

The healed case group (99) is that one in which every lesion of the patient is completely healed. All of the unhealed cases (22) were generally

and locally improved, and a few with multiple involvement had some healed wounds.

Of the three deaths, only one could be charged directly to the operative manipulations. This occurred in a boy eight years of age, who, for some unknown reason, suddenly went into shock and expired while the cast was being applied. The other two deaths occurred in two boys, of about the same age, whose pre-operative general conditions were very poor.

All of the amputations (six) were secondary; three were of the thigh, two of the leg, and one of the big toe. Two thigh cases and one of the leg were due to tuberculosis with secondary infection. The stumps all healed. A number of cases sent to the clinic for amputations were spared this by the Orr method.

The sixteen metastases occurred following the institution of the treatment. Three of these metastatic foci (two of the elbow and one of the sternum) healed without operative interference. In only one instance was there more than one metastatic focus. In one case multiple foci were present at the onset of treatment. Only two of the metastatic lesions remain unhealed. The cultures from two of the metastatic foci were sterile. The general healing time was well within the general average.

Of the twenty-nine cases in the reoperated group, twenty-one healed completely. Only four were due to secondary sequestrum formation. Two of these healed promptly. In the upper extremity lesions reoperation was necessary in only three instances. Fibrosis was the cause of reoperation in two cases, both of which proved to be very resistant to treatment. Soft-tissue wounds had to be enlarged in two cases, in spite of liberal primary incisions. In one case the suppuration spread remarkably up the fascial spaces, from the foot to the leg and thigh, necessitating counter soft-tissue drainage in the thigh and leg. Insufficient drainage and insufficient immobilization offended about equally in the rest of the cases. Twenty-four cases had two operations, two had three, two had four, and one had seven. Four of this class had multiple involvement at the time of treatment. The unhealed group will be discussed later.

TABLE II

GENERAL CLINICAL ANALYSIS

	Cases	*Lesions*	*Operations*	*Reoperations*	*Metastases*
Total	130	154	194	29	16
Healed	99 — 76.15%	112	144	21	14
Unhealed	22 — 16.92%	31	41	8	2
Amputations	6 — 4.6%	6	6	0	0
Deaths	3 — 2.3%	5	3	0	0

EXPLANATION OF TABLE III

1. In this table the primary lesions (51) are those that had no previous treatment, while the secondary did. This is in keeping with the classification of Dr. Orr. We find that the primary group has an average healing time of six and twenty-one hundredths months, in contrast to eight and ninety-five hundredths months for the secondary (92). The increased healing time, as evidenced above, is due to the secondary infection incident to the frequent antiseptic dressings previously employed. In all the following calculations, this distinction between primary and secondary lesions is not observed.

2. The upper extremity consistently shows a shorter period of healing, with its average of six and five-tenths months against the eight and sixty-eight hundredths months of the lower extremity. Weight-bearing is a definite factor in prolonging healing in the lower extremity. Patients of this group invariably began to bear weight too soon, because of their

TABLE III

FACTORS IN THE PERIOD OF HEALING

	Total	*Healed*	*Unhealed*	*Average time of healing, in months*
1. Primary lesions	51	46	5	6.21
Secondary lesions	92	66	26	8.95
Entire series	143	112	31	7.58
2. Upper extremity	29	25	4	6.5
Lower extremity	114	87	27	8.68
3. With primary sequestrum	19	12	7	8.1
With primary sinus	51	43	8	7.9
4. Single focus present	67	62	5	5.2
Multiple foci and joint involvement	54	37	17	9.96
5. Compound fractures	12	12	..	10.25

6. Duration of Disease:

Under 1 month	7.8 months
Under 6 months	9.4 months
Under 1 year	5.5 months
1 to 2 years	10.5 months
2 to 5 years	5.8 months
5 to 10 years	4.1 months

From one to three inclusive, we are dealing with the number of lesions. From four to six inclusive, the data bears on the isolated cases.

Primary cases are those that did not receive any previous treatment prior to the institution of Orr drainage. The secondary cases did. The rest of the data does not depend on this distinction and classification. See text for full explanation.

rapid general improvement and freedom from pain. The larger bones of the lower extremity permit more extensive destruction, which is a definite factor in lengthening the healing period of the group as a whole.

3. The most striking feature here is the primary sequestrum group (19). In this type of case the operation was done in the presence of a fully developed sequestrum. The conservative school refrains from performing adequate drainage until sequestrum formation. It is strikingly evident here that this does not have any material beneficial influence on the healing process. Practically all of this group belong to the secondary type, and illustrate the inevitable sequestrum formation following any inadequate surgical procedure. The Orr treatment aims at preventing this bone slough, which in itself is a constant source of reinfection and irritation. The group having chronic sinuses also emphasizes the influence of secondary infection in prolonging the disease process.

4. The shortest healing time is exhibited in the single-lesion case. Prompt treatment will lessen the chances of dissemination. Adequate immobilization was the greatest factor in producing these excellent results. A single lesion is more easily controlled and the plaster better tolerated by the patient. The better general condition, no doubt, played an important part.

When the joint is involved the healing time is prolonged. This is due to the more extensive involvement, and because no proper steps were taken in some cases to drain the joints separately and adequately.

5. All the cases associated with compound fractures healed completely, although the healing time was rather long. It must be remembered that these cases were all of the secondary class. We have not had occasion to treat any early cases of compound fracture by the Orr method.

6. The duration of the disease had little influence on the end result. Acute and chronic cases responded equally well. There seems to be no

TABLE IV

ANALYSIS OF EIGHTY-ONE CASES IN WHICH BACTERIOLOGICAL STUDIES WERE MADE

Organism	*Total No.*	*Healed*	*Unhealed*	*Average healing time, in months*
Staphylococcus	47	33	10	8.7
Sterile culture	12	10	2	5 8
Mixed pyogenic	9	6	3	14.7
Mixed tuberculous	8	5	3	?
Streptococcus	3	2	1	2.5
Bacillus	2	2	0	3.5

The ordinary pus-forming organisms represent the largest group. The mixed type appears to be the most virulent. The mixed tuberculous group is an interesting one.

reason for making any therapeutic distinction between acute and chronic stages of osteomyelitis. Most of the acute primary lesions healed well under the shortest period recorded in the general average figures.

There remain the five unhealed primary cases, as noted in the table. Three of these were still quite recent at the time of this study and were well on the way to recovery. Two were observed over six months. The latter patients did not cooperate regarding adequate immobilization.

EXPLANATION OF TABLE IV

The staphylococcus is the predominating organism. Of special interest is the group in which the cultures were reported sterile. Even these foci required almost six months to heal. In several of these cases the bone looked normal grossly, while pathological examination of the tissue revealed

TABLE V

ANATOMICAL DISTRIBUTION AND HEALING PERIOD FOR THE VARIOUS FOCI

Distribution	*Total*	*Healed*	*Unhealed*	*Average healing time, in months*
Upper extremity	29	25	4	6.5
Shoulder	6	4	2	2.7
Humerus	3	3	0	6.3
Elbow	2	1	1	?
Radius	4	4	0	17.3
Ulna	5	5	0	3.6
Wrist	1	1	0	1.0
Hand	1	1	0	5.0
Forearm	1	1	0	6.0
Fingers	4	4	0	2.0
Clavicle	2	1	1	?
Lower extremity	114	87	27	8.68
Hip	21	19	3	11.0
Femur	24	14	10	7.7
Knee	5	5	0	24.0
Tibia	37	27	10	5.7
Fibula	4	3	1	8.0
Ankle	1	1	0	12.25
Os calcis	8	5	3	6.0
Big toe	2	2	0	2.5
Metatarsal	10	10	0	6.0
Astragulus	2	2	0	4.0
Mid-tarsal	3	3	0	5.5

The majority of the lesions are of the lower extremity, but the upper has a better percentage of healed cases and a much shorter healing time. Of particular interest is the os calcis group. The weight-bearing joints are the most refractory lesions to clear up.

TABLE VI

DATA ON THE SURGICAL COMPLICATIONS AND CASTS

1. Immediate pre-operative and postoperative condition of the patients:

	Pain	*Temperature*	*Poor general condition*
Pre-operative	58 cases	37 cases	18 cases
Postoperative	7 cases	11 cases	21 cases

Shock ..... 11 cases
Hemorrhage ..... 1 case
Erysipelas ..... 2 cases

2. Later complications:
   Impacted vaselin gauze ..... 2 cases
   Skin irritation ..... 8 cases
   Pathological fracture ..... 1 case

3. Plaster casts:
   Average time cast was worn ..... 6.0 weeks
   Average number casts per case 3.8
   Minimum number casts per case 1.0
   Maximum number casts per case 18.0

inflammatory changes. It demonstrates conclusively the necessity of adequate drainage in the so called attenuated forms of osteomyelitis. The most malignant type appears to be the mixed type. It is of special interest to note that five of the eight mixed tuberculous infections healed completely. Several of these were undiagnosed clinically before operation because the shaft of the bone was atypically involved. This procedure is recommended in mixed tuberculous lesions similar to these.

EXPLANATION OF TABLE V

The lower end of the femur, while it has a shorter period of healing than the upper end (hip), does not show the high percentage of cases with complete healing. This is explained on the basis of inadequate immobilization because so many of these patients would not allow the application of a hip spica, when it was apparently only the knee which was involved. Involvement of the upper end of the tibia required a longer healing period. The nearer to the joint, the longer the healing time, especially when the joint is a large one. In some of the hip cases, the ischium or pubis became involved, resulting in inadequate drainage via the original hip approach. Of especial interest are the findings regarding the os calcis. Its structure is largely cancellous tissue which is known to be preeminently poor in regenerative power. Most writers advocate amputation if there is no healing within six months. The x-ray findings in this series show a dense sclerosing reaction. Since this study has been undertaken, there has been a reoperation in one case, which proved to be tuberculous.

EXPLANATION OF TABLE VI

1. Practically the only poor postoperative conditions were found to be in the original poor operative risks, and even they did not react excessively. Of course, in these, thoroughness and nicety of execution had to be regretfully sacrificed for speed. The bone work was in some instances incomplete, and accounts for most of the cases in which reoperation was necessary; thereby lengthening the total healing time. It is hardly necessary to state that, if the operation is done early enough, the general condition will permit thorough drainage.

That the patient is practically free from postoperative pain is clearly borne out by the figures. The temperature drops spectacularly, sometimes within twenty-four hours; in very few cases did it continue for more than a week. The atypical temperature reactions occur where adequate drainage cannot be established. The general condition begins to improve rapidly. The blood count approaches the normal level, the red blood cells as well as the white. It is remarkable how the red blood count remains near the normal level even in those cases resistant to treatment. The appetite improves, and sleep is undisturbed.

2. With the exception of the fatal cases, practically all recovered readily from the immediate postoperative complications. There was only one case of severe hemorrhage in which a transfusion was required. There were many transfusions given as a pre-operative measure to improve the general condition. One must use the ordinary precautions in working about the gluteal region especially, in order to avoid the superior gluteal artery. The dense sclerotic bone in the lower end of the femur, encountered in chronic cases, sometimes offers troublesome hemorrhage.

There was only one case of pathological fracture (femoral), which could have been avoided. The child was allowed to go without a cast for several days. The fractured area went on to extensive sequestration of the middle third of the femur. This was recently removed *in toto*, and was followed by marked local and general improvement.

In only two cases did it become necessary to administer an anaesthetic in order to remove impacted vaselin gauze. This was conditioned by the low melting point of the vaselin used when the method was first initiated here.

3. It is necessary at times to change casts frequently, due to excessive drainage, while some of our cases maintained one cast as long as three months. There has been much superficial criticism of the Orr technique on this account. The important thing is to change the dressing under aseptic conditions. When the Orr technique was first used in this clinic, it was difficult to educate the practitioners to the seemingly unscientific axiom of non-meddling with the wound. Many of the casts were removed before it was necessary. This is one of the reasons, we believe, that our results do not compare more favorably with Dr. Orr's. A rigid rule must be enforced with clinic cases. When the case is under the control of the operating surgeon, he can change casts with impunity.

TABLE VII

ANALYSIS OF QUESTIONNAIRES

Total answers received.....86
Healed.....71
Unhealed.....15

Healed Group.

1. General condition:
   - Good.....64 cases
   - Fair.....6 cases
   - Poor.....1 case
2. Body weight:
   - Gaining.....18 cases
   - Unaltered.....49 cases
   - Losing.....4 cases
3. Postoperative scar:
   - Tight.....26 cases
   - Adherent.....28 cases
   - Painful.....8 cases
   - No comment.....9 cases
4. Limitation of joint motion:
   - None.....46 cases
   - Slight.....18 cases
   - Ankylosis.....7 cases
5. Function:
   - Good.....65 cases
   - Fair.....6 cases

Of the unhealed group, only two were not satisfied with the treatment.

Note the strikingly good functional results obtained.

EXPLANATION OF TABLE VII

Eighty-six patients promptly replied to our questionnaires. Those of the unhealed group professed as much enthusiasm for the treatment as the healed. None of them had any resultant, continuous discomfort from the scars. The scars did not inhibit function.

The general conditions show that the healing is complete. They would certainly not thrive so well if pocketed foci of infection remained.

The functional results are striking. Only six patients are forced to use some sort of support to get about; several require only a cane.

EXPLANATION OF TABLE VIII

There are a number of cases in this group that are greatly improved and still under observation. We see at a glance that inadequate immobilization is the greatest cause of non-healing within a reasonable time. Nature will take care of the drainage in many instances but does not effect adequate rest as a rule. That must be accomplished by the surgeon with a well-fitting cast in the neutral position.

TABLE VIII

ANALYSIS OF THE UNHEALED GROUP (22 Cases)

1. Factors in prolonging convalescence and non-healing:
   - Inadequate immobilization ..... 9 cases
   - Inadequate drainage ..... 3 cases
   - Secondary sequestration ..... 2 cases
   - Premature fibrous reaction ..... 2 cases
2. Other factors in non-healing:
   - Secondary infection.
   - Early weight-bearing.
3. Cases still too recent to judge ..... 6 cases

Secondary infection, as proved by culture, occurred in one case in spite of our vigilance. It is readily understood how much more often it might occur in those cases where frequent dressings are practised.

When, for some reason, there is fibrosis early in the postoperative stage or at the time of operation, one may look forward to a long drawn-out convalescence. Fibrosis is a biologic end-result process and does little or nothing in the way of further regeneration, due to the lack of "stimulus of incompleteness" (Hunter).

Epithelization of the cavity and sinus tract occurred in one case, not included in this study.

TABLE IX

THE SUPPURATIVE ARTHRITIS GROUP

Total number of cases	16
Age incidence	8 months to 58 years
Average duration of illness	7 weeks
Reoperated	none
Metastasis	none
Organisms recovered:	
Sterile culture	3 cases
Staphylococcus	4 cases
Anatomical Distribution:	
Hip	7 cases
Knee	6 cases
Ankle	1 case
Wrist	1 case
Healed	8 cases
Unhealed (insufficient observation)	8 cases
Average healing time	4.6 months
Results of healed group:	
Good motion	5 cases
Ankylosis	3 cases

The comparatively short duration of the healing time as compared with joint involvement in the osteomyelitic group is remarkable.

TABLE X

THE SOFT-TISSUE SUPPURATIVE GROUP

Total number of cases	9
Type of involvement:	
Subgluteal bursitis	6 cases
Prepatellar bursitis	1 case
Hand	1 case
Heel	1 case

EXPLANATION OF TABLE IX (Suppurative Arthritis Group)

There were four acute cases. Five had previous treatment, and three had a history of trauma. The onset was sudden in all of them. Definite foci of infection were evident in about half the cases, and were: mumps, otitis media, influenza, and sore throat. Two followed arthroplasty. There was only one doubtful metastasis to the mastoid region. Only one developed a complication postoperatively.

The fair percentage of good functioning joints bids well for this method. Orr* does not advise the insertion of the pack into the joint cavity, but covers the incision with vaselin gauze. In our series the vaselin gauze was placed into the soft-tissue opening, reaching to, but not into, the joint.

DISCUSSION

An analysis of the Orr method of treatment in 130 cases of osteomyelitis, sixteen cases of suppurative arthritis, and nine cases of extensive soft-tissue suppuration is presented. The results, as shown by this statistical study, warrant our confidence in the Orr treatment as the method of choice in the treatment of osteomyelitis and allied conditions.

The Orr method may be accurately called the gospel of adequate drainage and adequate immobilization. This is surgically accomplished after the diagnosis is made. Technically it means an adequate approach to the bone, saucerization, and removal of all the involved portions of bone; the insertion, lightly, of a generous vaselin pack; and the application of a cast, in a neutral position of the limb, which immobilizes the joints below and above the involved area. Strict adherence to details is necessary, although this is a simple, universal routine method for the "rank and file of the profession".

That this method is scientific and rational is borne out from the results obtained and the pathology. The essential pathology of osteomyelitis is a regressive thrombo-embolic process which usually progresses to extensive bone destruction and sequestration. Saucerization of the bone with the removal of all diseased portions, as early as possible, is therefore the rational way to control it. When small sequestra do form, and they often do, with the Orr method, they are extruded easily and spontaneously, especially at the first postoperative change of plaster.

*Personal communication.

To prevent secondary infection is the second great aim of this treatment. This is successfully accomplished by the principle of non-interference with the postoperative wound. Under such ideal conditions the wound will take care of itself without the superfluous use of antiseptics.

There should be no hesitancy or timidity in the prolonged use of plaster immobilization. The excellent end results, the absence of postoperative pain and temperature, overwhelmingly overshadow the occasional temporary atrophy and stiffness that may result.

Of this series of 130 unselected cases of osteomyelitis, ninety-nine completely healed. The general average time of healing was seven and fifty-eight hundredths months. Those patients who were operated on primarily by the Orr method, without previous treatment, healed in six and twenty-one hundredths months. Those cases treated secondarily by the Orr method healed in eight and ninety-five hundredths months.

The upper extremity involvements healed in six and five-tenths months, as against eight and sixty-eight hundredths months in the lower. All conditions favoring secondary infection, such as the presence of sequestra or chronic sinuses, prolonged the healing time to eight and six-tenths months. Other conditions having a detrimental influence on healing were the presence of multiple foci of infection or joint involvement. The duration of the disease or the age of the patient had little or no regular relation to the regenerative healing power of the bone.

There were three deaths and six secondary amputations. Only one death could be definitely attributed to the operative procedure. Of the amputations, three were of mixed tuberculous infection.

In this series every bone except the spine and skull was included. There were some cases of osteomyelitis of the spine and sacroiliac joints treated by the Orr method not included in this group, because that is a chapter in itself and deserves more space than is available here. There were possibly about twenty cases in this group resulting favorably.

The cases associated with compound fracture all healed completely. In the same way those cases of osteomyelitis due to operative or postoperative infection healed with no detriment to the original operative intentions.

FIG. 3

Donald G. Healed in five months. Had corrective subtrochanteric osteotomy after healing.

The death rate was very low, there being three deaths out of 130 cases exhibiting 154 lesions, upon which 194 operations were performed. It is not a wise policy to do too much surgery at one sitting. One should not operate on several foci simultaneously, especially when the femur is one of them. Operation on the latter bone usually produces some degree of shock.

When healing occurred following the Orr treatment it was quite permanent. The old adage "once an osteomyelitis, always an osteomyelitis" does not hold any more. Solid healing was demonstrated by x-rays and direct examination of the tissues in those instances where secondary operations were necessary.

The answers to eighty-six questionnaires are a tribute to the Orr method.

CASE SUMMARIES

CASE 1. Lillian M., aged nine. Compound fracture of the left forearm, nine weeks' duration. Had had drainage before coming to hospital.

December 6, 1929: Orr drainage; recovery uneventful.

December 18, 1929: Discharged in original postoperative cast.

January 6, 1930: Seen in out-patient department. Wound draining profusely; granulations abundant and healthy. Cast reapplied.

February 5, 1930: Drainage still considerable; progress of wound satisfactory. Cast reapplied.

March 3, 1930: Superficial abscess on the dorsum of involved part opened in out-patient department. No complaints. Cast reapplied and patient discharged.

April 2, 1930: Seen in out-patient department. Wound is practically healed. Dressing applied, and patient discharged in a cock-up splint.

May 15, 1930: Seen in out-patient department. Wound is entirely healed; general condition excellent. Is to have corrective osteotomy of original deformity done at a later date.

CASE 2. Donald S., aged eleven. Persistent drainage from the right tibia for the past seven years; had multiple foci originally. Several operations before his admission, with no healing. On admission he complained of pain and was running a temperature.

June 15, 1928: Orr drainage; uneventful recovery.

June 18, 1928: Discharged in cast.

July 11, 1928: Seen in out-patient department. The wound is draining profusely. Cast reapplied.

August 9, 1928: Seen in out-patient department. The wound is filling in with abundant healthy granulations. Cast reapplied.

September 19, 1928: Seen in out-patient department. Wound is almost completely filled in; drainage scant. Cast reapplied. Discharged; to be up on crutches.

November 14, 1928: Completely healed. No cast; to use the crutches for another month, and gradually dispense with them.

December, 1929: Seen in out-patient department. Patient has been in excellent condition, and has long since resumed his normal activities.

CASE 3. Donald G., aged ten (Fig. 3). Osteomyelitis following subgluteal bursitis of three weeks' duration. On admission he was very septic, and complained of considerable pain in the hip, on the right side.

July 29, 1927: Orr drainage. Postoperative course rather unusual because he still had some pain and temperature.

August 7, 1927: Temperature; became septic.

August 13, 1927: It was decided that there was inadequate drainage, and the patient was operated upon again. A counter opening was made on the anterior surface of the upper femur. He developed an acute infectious disease, and was sent to isolation in the original cast applied at the second operation.

September 4, 1927: Returns to the ward and the cast is removed. The condition is good, and the wound is healing in nicely. Cast is reapplied.

October 4, 1927: Cast changed. The wound is healing satisfactorily.

November 4, 1927: Cast changed. The granulations are healthy, and drainage is scant.

January 9, 1928: First operative wound is healed completely. The hip is stiff. Cast reapplied.

March 26, 1928: All wounds are completely healed. Hip is in some slight flexion and adduction deformity. Patient allowed up on crutches without a cast.

July 9, 1928: Returns with a well developed flexion and adduction deformity of the hip.

July 16, 1929: Osteotomy done through the lesser trochanter, to correct the deformity. *The former site of involvement was found to be completely healed in by dense bone.* The wound healed with little difficulty, and sound union resulted.

February, 1930: Patient is in excellent condition and has resumed his normal activities.

CASE 4. Thadeus W., aged thirty-three (Fig. 4). Compound fracture of the right humerus of eight months' duration. Had had several operations before coming to the clinic. There is a persistent draining sinus, pain, and limitation of motion of the upper extremity.

March 20, 1928: Orr drainage; recovery uneventful.

March 25, 1928: Discharged in cast (shoulder spica).

April 20, 1928: The wound is somewhat indurated, and although the patient had no complaints, he was admitted for several days without a plaster dressing in order to watch the wound and the general condition. Discharged after three days in a platform splint, with instructions not to disturb the dressing.

May 24, 1928: Wound is completely healed. Instructed in shoulder exercises. He soon recovered good motion of the arm.

August 12, 1929: Doing heavy manual labor with no discomfort.

CASE 5. Thomas D., aged fifty-seven. Osteomyelitis of the metacarpal bones of the right hand, of two months' duration. Complicated by dislocation fracture of the capitate bone and phalanges.

January 16, 1928: Orr drainage, recovery uneventful.

January 27, 1928: Discharged in cast.

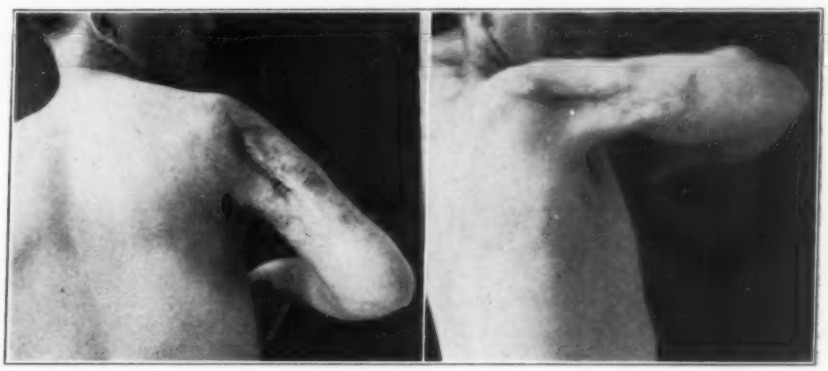

FIG. 4

Thadeus W. Healed in three months. Good function of arm. Old compound fracture.

February 2, 1928: Wound is still indurated, but progressing well. X-ray shows beginning condensation of bone in the involved area.

February 29, 1928: Greatly improved. Splint applied.

March 23, 1928: Only one sinus still slightly draining.

May, 1928: Completely healed. Physiotherapy started. Good motion resulted, except in the fourth and fifth fingers.

CASE 6. Lewis C., aged twenty-one (Figs. 5-A and 5-B). Right foot crushed five months previously, had had several operations previous to admission. Presents a markedly swollen, discolored, and distorted right foot which is painful and functionless. X-ray reveals marked destruction.

September 3, 1929: Orr drainage (in spite of patient's desire for amputation). Considerable bleeding and drainage postoperatively, but no pain or temperature.

September 12, 1929: New cast applied because of the marked seepage. The dressing nearest the vaselin pack was not disturbed.

FIG. 5-A

FIG. 5-B

Lewis C. Showing lesion injected with lipiodol. Healed in seven months. Foot has good function.

October 1, 1929: Cast changed.

October 30, 1929: Cast changed. The wound is progressing satisfactorily, but the drainage is still considerable.

November 16 1929: Cast changed. Condition is excellent.

December 21, 1929: Cast changed. Wound closing in with healthy granulations; the discharge is diminished.

January 24, 1930: Wound almost completely healed. Cast applied.

March 25, 1930: Wound completely healed.

March 31, 1930: Operative correction of the original deformity. Wound healed normally. Patient discharged in a leather reinforced anklet. No weight-bearing.

August 28, 1930: Last examination on record. Patient to resume weight-bearing gradually. The foot is in good position and painless. The x-rays show disorganized tarsi but no evidence of active destruction.

Recent questionnaire answered states that patient is using the foot, but that it is still somewhat stiff.

CASE 7. Buck T., aged eight (Figs. 6-A and 6-B). Osteomyelitis following bone-graft operation for the correction of non-union and deformity of right tibia following fracture.

. This case illustrates that in some instances the element of rest with insufficient drainage is not enough to cause healing. After the infection was noted, the wound was not disturbed because it was hoped that the drainage would be adequate from the original operative wound. Drainage persisted for eleven months, with very little improvement.

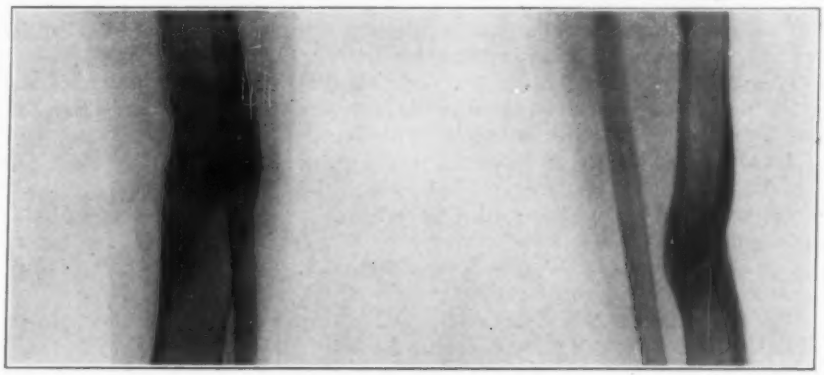

FIG. 6-A

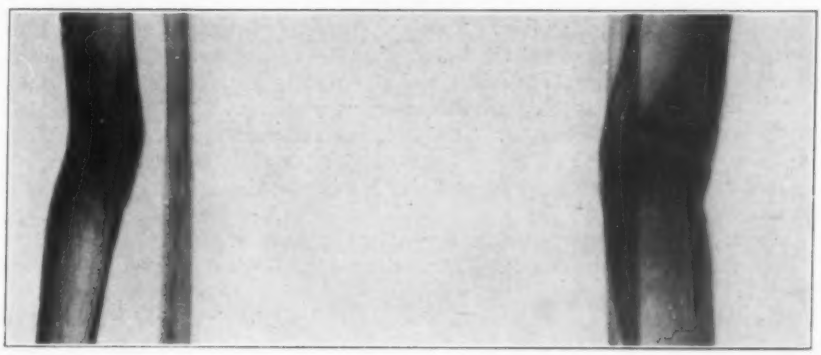

FIG. 6-B

Buck T. Infection followed bone graft for pseudarthrosis of tibia. Healed in six months.

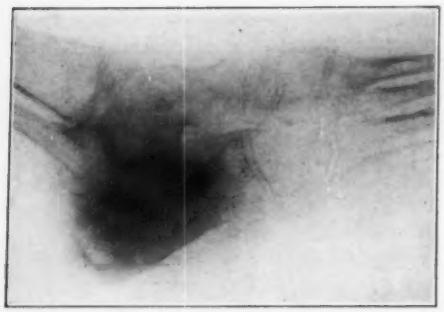

FIG. 7-A

FIG. 7-B

Loren B. Healed in eight months. Involvement of os calcis. Intense recalcification and ossification were noted.

There was formation of a pseudarthrosis at the site of the graft operation. No free pus was found at the time of Orr drainage, but the eburnated bone about the bone ends was removed.

February 8, 1929: Orr drainage; uneventful recovery.

March 8, 1929: Cast changed. No discomfort.

April 24, 1929: Cast changed. The condition is good, and the wound healing.

July 12, 1929: Completely healed. Given a long leg brace.

Good bony union resulted several months later. Questionnaire states that patient is up and about normally, and has no stiffness or other disability.

CASE 8. Loren B., aged fourteen. Osteomyelitis of the right os calcis, of seven months' duration, which was drained previous to admission. Presents a painful, deformed, and swollen foot, with sinuses about the heel.

December 24, 1928: Orr drainage; uneventful recovery.

January 5, 1929: Discharged in original cast.

February 9, 1929: Cast removed. Wound is filling in slowly; drainage is scant. Discharged in cast.

April 6, 1929: Wound is almost completely healed.

August 5, 1929: Completely healed.

Patient wore a cast until February 5, 1930. Following this he was allowed to walk without fixation.

CASE 9. Dorothy I., aged three. Osteomyelitis of lower end of the femur, of two months' duration. Had had previous treatment. Right knee is swollen, painful, and has a draining sinus.

January 9, 1930: Orr drainage. Knee was opened, and sequestrum removed from the epiphysis of the lower end of the femur. She ran a slight temperature for about a week. Had some nutritional difficulties, and remained in the house for about a month.

January 30, 1930: Cast changed, due to excessive seepage.

March 6, 1930: Cast changed. The pack has extruded spontaneously. Wound filling in.

April 2, 1930: Patient's general condition has improved considerably. Very little drainage. Cast changed.

May 16, 1930: Has been bearing some weight in the cast. Cast changed.

June 16, 1930: Wound healed. Fitted with brace. Patient is now up and around normally.

CASE 10. Walter K., aged fifteen. Osteomyelitis of the right hip for the past two years. Several previous operations had been done before his admission to the ward. Has considerable radiating pain in the right hip; hip is ankylosed, no sinuses present.

July 29, 1929: Orr drainage. Postoperative hemorrhage about two hours afterward. Blood transfusion and saline given. Recovered.

FIG. 8

Joseph S. Local decalcification to supply the needs of the lesion was observed. The joint space and epiphyseal lines are uninjured. Time of healing was eighteen months.

August 16, 1929: Discharged in new cast.

September 16, 1929: General condition markedly improved. There is some excoriation of the skin present. Admitted for several days until skin healed. Cast was then again applied and he was discharged.

October 25, 1929: Cast changed. The wound is filled with healthy granulations, and drainage is decreased.

December 5, 1929: Healed completely.

January 29, 1930: Last seen, and up and about normally. (Rapid healing, no doubt, in part due to the ankylosis present which insured the maximum amount of rest.)

CASE 11. Gerald T., aged seven. Osteomyelitis of the lower end of the right femur, of about four months' duration. Has pain, swelling, and deformity of the right knee.

May 27, 1929: Orr drainage; hip spica applied. Uneventful recovery.

June 20, 1929: New cast applied. Condition good.

July 29, 1929: Cast changed. (Changed from a hip spica, which is sufficient for the lower end of the femur, to a long leg cast.)

September 2, 1929: Fell and broke the cast about a week ago. There has been very profuse drainage since. New long leg cast applied.

October 17, 1929: Still very much drainage. Granulations are not as healthy as they should be to promote healing. Long leg cast reapplied.

The patient improved, but a small sinus persisted until April 14, 1930, at which time a sequestrum was demonstrated on x-ray examination.

April 14, 1930: Second Orr drainage; uneventful recovery.

April 30, 1930: Cast changed. Again the spica was changed to a long leg cast.

Patient went on this way for several months until the long leg cast was changed to a spica, and he was told to remain in bed. There has been considerable improvement.

February 18, 1931: Wound practically healed. (This patient began to improve steadily following adequate immobilization.)

SUMMARY

The Orr method is recommended as a routine procedure in the treatment of osteomyelitis and allied conditions because:

1. It is based on the principle of adequate drainage and adequate immobilization.
2. It is a painless, economic, universal method, applicable in any stage of osteomyelitis.
3. The period of hospitalization is greatly decreased.
4. Transportation of the patient is simplified.
5. It prevents sequestration.
6. The general condition of the patient is improved.
7. A good functional end result is obtained.
8. It minimizes loss of limb by amputation.
9. The death rate is insignificant.
10. It is the only treatment that satisfies all the tenets of orthopaedic surgery.
11. It is a procedure suitable for the rank and file of the profession.
12. It shortens the postoperative course of a condition which, previous to the advent of the Orr method, was, in many cases, intractable.

It is a pleasant duty to acknowledge appreciation of the valuable suggestions, encouragement, and the correction of the manuscript by Dr. Steindler.

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RECURRENT FRACTURE OF THE PATELLA
Report of an Atypical Case

BY MILTON J. WILSON, M.D., NEW YORK, N. Y.

Refracture of the patella has been the subject of innumerable articles but the second fracture has usually occurred through the seat of the original injury. Refracture through another portion of the bone has been mentioned as having occurred from eight months to twenty-six years after the primary break.

Remy* records two cases in which the same patella was fractured twice but not in the original line, Henry* one case of refracture eight months after the first fracture, and Vallas* a case twenty-six years after the primary break.

Murray* tells of an interesting accident six months after a fracture of the patella with healing, in which neither the bone nor the callus gave way but the ligamentum patellae was torn loose.

The case reported here occurred only six weeks after the original injury, and the second line of fracture was below the first one.

CASE REPORT

W. W., a male, age forty-seven years, was admitted to the Metropolitan Hospital on October 19, 1929, with a history of having slipped and fallen (but not on the right knee). He also stated that he had been operated upon at the Harlem Hospital on September 9, for a fracture of the right knee-cap. Later investigation corroborated this statement. Examination showed considerable swelling and ecchymosis of the right knee joint with separation of the patella into two large fragments. The x-ray pictures show the seat of the previous fracture between the middle and upper thirds, while the second

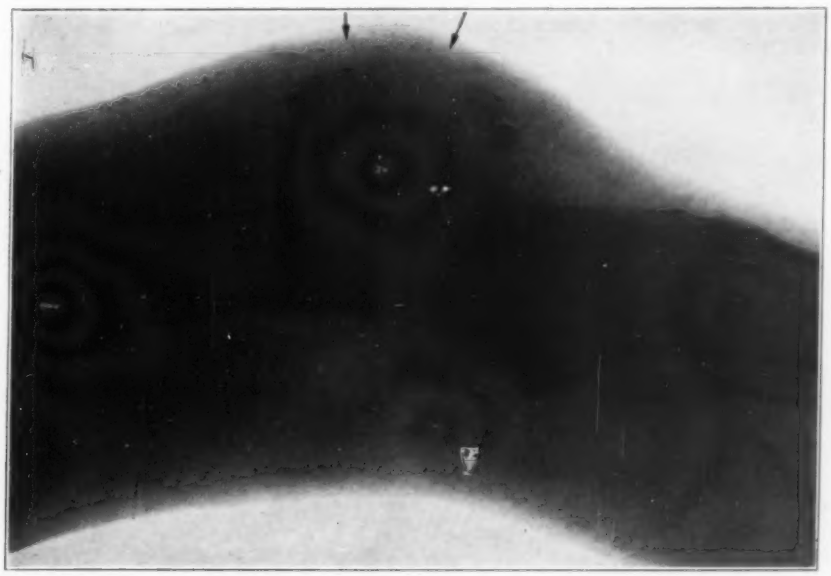

Fig. 1

FIG. 2

fracture with separation can be seen to have occurred between the middle and lower thirds of the bone.

At operation three days after admission the original tear was found to be well healed with scar-tissue formation and the capsule was torn well down on both sides. After the usual trimming of the periosteum and cleansing of the joint with ether, the capsule was sutured with interrupted kangaroo tendon and chromic catgut.

The patient made an uneventful recovery and left the hospital on crutches three weeks after operation. He has not been seen since.

*Speed, Kellogg: Textbook of Fractures and Dislocations. Ed. 2. Philadelphia, Lea & Febiger, 1928.

BILATERAL FRACTURE OF THE CLAVICLE

REPORT OF AN ATYPICAL CASE

BY MILTON J. WILSON, M.D., NEW YORK, N.Y.

A review of the literature in reference to bilateral fracture of the clavicle reveals that these fractures, although very rare, are invariably due to compression of the shoulders toward each other. However, one case is reported where both fractures were due to direct violence, the victim having been trampled on by a horse.

The case reported here is also atypical in that the fracture was induced by direct violence on one side and indirect violence on the other.

CASE REPORT

M.S., a male, age seven years, was admitted to Flower Hospital on May 8, 1926, with a history of having been struck by a bicycle while playing in the street and knocked

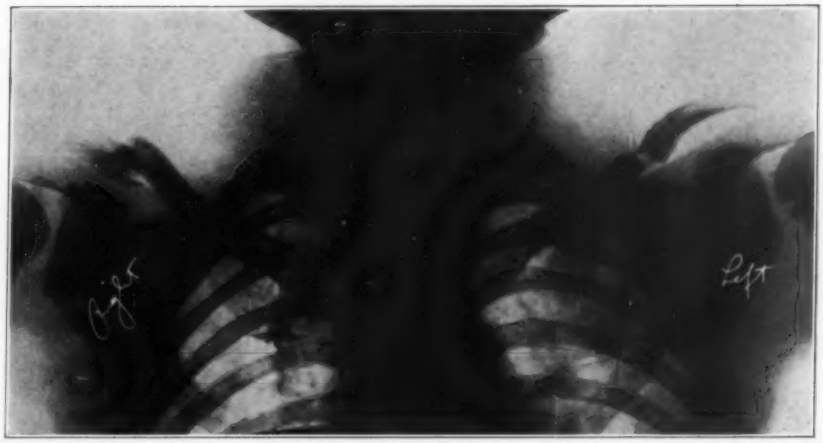

FIG. 1
X-ray taken May 10, 1926.

FIG. 2
Postoperative x-ray.

down upon the curb stone. The direct injury was received over the left clavicle and the patient was thrown on the right shoulder. Examination showed swelling, tenderness, and crepitus of both clavicles and deformity on the right side. X-ray showed a transverse fracture in the middle third of the left clavicle with slight displacement, and a fracture of the right clavicle at the junction of the middle and outer thirds with overriding.

A figure-of-eight plaster-of-Paris bandage was applied and, but for a slight cough for a few days, the patient made an uneventful recovery. Examination on November 15, 1930, showed no deformity and perfect function.

LUETIC SYNOVITIS OF THE KNEE

BY JULIUS S. NEVIASER, M.D., WASHINGTON, D.C.

Although luetic synovitis of the knee is a known definite clinical entity, it is not often diagnosed, especially in the early stages. This may be attributed to several causes,—namely, that joint symptoms may be manifold, the neglect of having a Wassermann done, or the presence of a negative roentgen-ray examination.

The results of ten cases are submitted in this manuscript. Abstracts of several cases are given to bring out some of the important points that should be helpful in arriving at a correct diagnosis.

CASE REPORTS

CASE 1. H.D., male, thirteen years old. Patient had noticed a gradual painless swelling and stiffness of both knees for the past week. There was no history of trauma. Was admitted to the hospital and legs put in traction to overcome the ten degrees' flexion deformity that was present. Thirty cubic centimeters of a yellowish mucogelatinous fluid were aspirated from the right knee; forty cubic centimeters of a similar fluid were aspirated from the left knee. Wassermann reaction of the joint fluid was four plus. The blood Wassermann gave a similar reaction. Roentgen-ray reports were negative. The boy was given antiluetic treatment and the knee joints returned to normal. This patient was seen after one year of anti-luetic treatment and has had no return of symptoms.

CASE 2. C.I., male, eight years old, was admitted to the clinic on April 11, 1930, with the history of slight pain and swelling of the left knee, of six weeks' duration. Patient walks with a limp. Flexion of the knee is checked at forty-five degrees and extension at 160 degrees. The knee is somewhat warm. The roentgen-ray diagnosis was: slight effusion, no destruction or atrophy of the bone. The knee was immobilized in plaster for one week. *Reexamination:* May 7, 1930. Knee was still swollen and warm. Flexion limited to forty degrees. The roentgen-ray showed effusion again, but no bony changes. On May 9, 1930, the knee was aspirated; fifteen cubic centimeters of clear fluid were obtained. Wassermann was four plus on the fluid and blood. Antisyphilitic treatment consisting of mercurial ointment and bismogen injections were given. Patient was very much improved after two weeks and the motions were free. He was seen last on September 17, 1930, at which time the pain and swelling had disappeared. The function was normal and the Wassermann negative.

CASE 3. O.J., male, twenty-five years old. Patient came to the clinic on January 19, 1931, complaining of painless swelling and stiffness of both elbows and both knees for the past seven months. Roentgen rays of all the joints showed effusion, but were negative for bone changes. Each joint was aspirated and a light greenish, mucogelatinous fluid was obtained, ninety cubic centimeters of fluid from the right knee and seventy-five cubic centimeters from the left knee. Fifteen cubic centimeters were aspirated from the right olecranon bursa and ten cubic centimeters from the left olecranon bursa. Wassermann tests on all these fluids were positive as well as the blood Wassermann. Patient was given antiluetic treatment with complete disappearance of all the swellings.

COMMENT

1. Although the diagnosis of syphilitic synovitis in the adult is not difficult, the diagnosis is often missed in the hereditary form occurring in children. The hereditary form manifests itself as a chronic synovitis, and a persistent hydrops of both knees is not uncommon. It should be

emphasized, however, that pain and tenderness is *less* than the swelling and presence of fluid would indicate. Evidence of syphilis elsewhere may be lacking.

2. Roentgen-ray examinations of these early cases are always negative.

3. As Todd states, the Wassermann reaction of the blood may be negative, but that of the joint fluid which is aspirated may be positive. The blood test has been positive in all our cases except one, while the joint fluid has been positive in all the cases. The Wassermann test on the joint fluid was done according to the technique described by Kling. It is, therefore, very important to examine both the joint fluid and blood for the Wassermann reaction, since early diagnosis before bone involvement is most essential.

4. The history of trauma is apt to make one forget the possibility of luetic synovitis. However, the association of leutic synovitis and trauma is not uncommon, according to Kling.

Therefore, a relatively painless chronic hydrops of the knee with a negative roentgen-ray examination should make one suspect lues. It is only after both the blood and joint fluid are examined for a Wassermann reaction that lues may be ruled out.

TREATMENT

We have used various forms of antiluetic therapy, all giving good results. We must emphasize that early cases of luetic synovitis will respond quickly to antiluetic treatment. Although Campbell states that the effusion may persist in some cases after thorough antiluetic treatment, necessitating synovectomy, this did not occur in any of our cases. In the late second or third stage of the acquired form, treatment is not as beneficial to the joint condition. This is apparent when we realize that in early cases there is no bone involvement. After bone involvement, even with efficient treatment, it will be doubtful if a good functional joint will be obtained.

SUMMARY

1. Luetic synovitis of the knee, especially in children, is very often erroneously diagnosed, as roentgen-ray examinations are negative.

2. In chronic hydrops of the knees with a negative roentgen-ray report, it is important to do a Wassermann on the joint fluid as well as on the blood.

3. The history of trauma does not rule out the possibility of lues, for the two may be associated.

4. Since luetic synovitis, before bone involvement, responds quickly to antiluetic treatment, an early diagnosis is essential.

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A GROOVE FOR THE HYPOGASTRIC VESSELS

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

Director of Roentgenology, New York Orthopaedic Dispensary and Hospital

In the roentgenographic diagnosis of arthritis at the sacro-iliac joints error may arise when a groove in the ilium for the hypogastric vessels causes the iliac margin of the joint inferiorly to appear sharply pointed, simulating the calcareous deposit or lipping of arthritis.

The prevalence of this groove is not generally recognized. A recent examination of one hundred cases showed the groove present in some degree in eighty-six.

The groove may vary greatly, as in the illustrations, in which the sacral margin of the sacro-iliac joint is outlined in ink and the bracket indicates the extent of the groove. They show:

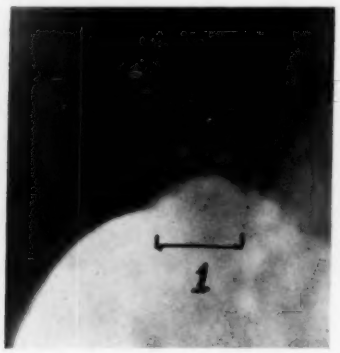

FIG. 1

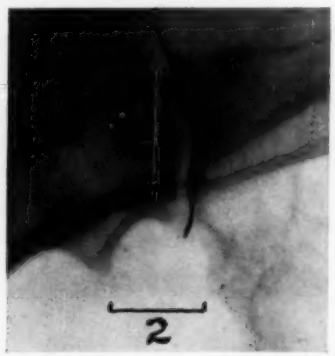

FIG. 2

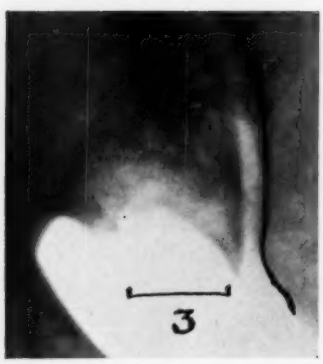

FIG. 3

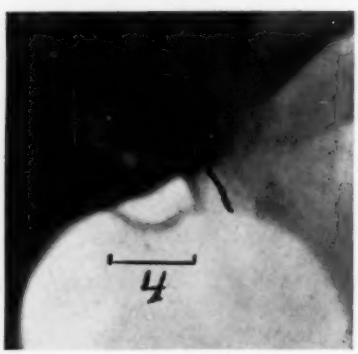

FIG. 4

1. A shallow groove.
2. A deep groove involving both ilium and sacrum.
3. A deep groove confined to the ilium and simulating arthritic lipping at the joint.
4. Actual canal for the hypogastric vessels.
5. The relation of the arteries to the joint, as shown in arteriosclerosis.

The groove may be seen in an anterior-posterior view but frequently it is better demonstrated in an anterior-posterior view oblique inferior-superiorly, commonly called the forty-five-degree view. The groove sometimes involves both ilium and sacrum but is usually confined to the ilium. If there is evidence of such a groove no deduction as to arthritis can be drawn from the presence of pointed lipping at the margin of the groove and sacro-iliac joint unless the lipping is present on both the iliac and sacral side of the joint, or unless it is so dense or exuberant as to be definitely pathological.

FIG. 5

CHRONIC CORTICAL ABSCESS OF THE ULNA CAUSED BY THE BACILLUS TYPHOSUS

BY EDMUND HORGAN, M.D., WASHINGTON, D.C.

When a chronic localized abscess occurs in bone, it is usually situated in the cancellous tissue or in the medullary cavity of a long bone. The clinical signs and symptoms, the pathological changes, and the surgical treatment of the central bone abscess was first described by Sir Benjamin Brodie in 1832[1]. Since his description this condition has been referred to as Brodie's abscess.

A chronic circumscribed abscess occurs much less frequently in the cortex of a long bone than in the cancellous or medullary tissue. Pyogenic bacteria can find more favorable conditions for the formation of an abscess in the cancellous or medullary tissue than in the dense cortical tissue. An abscess in the cortex of a long bone should not be classified as a Brodie's abscess, even though the pathological and clinical signs of the cortical abscess are similar to those of the central bone abscess. Of the eight cases of bone abscess which Brodie reported in 1845[2], all were in the cancellous tissue in the upper or lower end of the tibia. After the report of his cases Brodie said: "When the tibia is enlarged from a deposit of bone externally —when there is excessive pain, such as may be supposed to depend on extreme tension, the pain being aggravated at intervals, and these symptoms continue and become aggravated, not yielding to medicine or other treatment that may be had recourse to—then you may reasonably suspect the existence of abscess in the center of the bone". These conditions were present in Brodie's first case of bone abscess in 1824. The abscess, a small cavity full of dark pus surrounded by bone harder than normal, was discovered after the limb was amputated and divided longitudinally. It was then evident to Brodie that the violent pain which the patient had at times suffered was caused by the inflammatory reaction in the bone. It was also evident to him that had he known of the existence of an abscess within the bone, the patient might not have had to lose his leg. This deduction proved correct. Brodie had six additional cases which he treated by opening and draining the abscess without resorting to amputation.

The chronic circumscribed abscess in the central portion of a long bone is of fairly frequent occurrence, but it is rarely associated with an infectious fever, such as typhoid. The organism usually found in the pus taken from the cavity of a bone abscess is the staphylococcus aureus or the staphylococcus albus. Among 141 collected cases of chronic localized bone abscess published by Gross[3], there were only six cases in which the abscess had developed during or following an attack of typhoid fever. In one of these cases the bone abscess was opened a year after the attack of typhoid. The

bacillus typhosus was found in pure culture in the pus taken from the abscess. A bacteriological report was not given in the other five cases. McWilliams[4], in 1921, reported a case of a man who, soon after an attack of typhoid fever, had severe pain in the lower third of the right tibia. He had intermittent attacks of pain for twelve years. Then a cavity full of thick yellow pus was uncovered. Media inoculated with the pus yielded the bacillus typhosus. In a survey of thirteen cases of Brodie's abscess treated at the Mayo Clinic during a period of eighteen years, Henderson and Simon[5] found that in three of the cases "the onset very definitely followed an attack of influenza, and in one it followed an attack of scarlet fever after local trauma".

The bacillus typhosus has the ability to live in bone for long periods of time. In an article on "Bone and Joint Disease in Relation to Typhoid Fever", published in 1916, Murphy[6] cited an instance in which the bacillus typhosus was found in pure culture in pus from a bone which had been draining for six years. In the same article Murphy noted that the bacillus typhosus was found in seventy-four out of ninety-nine cases of bone disease associated with typhoid.

Trotter[7], when considering the diagnostic factors in the swellings of long bones, stated: "When typhoidal infection gives rise to a chronic abscess, there is nothing in the signs of the lesion itself to distinguish it from an ordinary chronic abscess due to the staphylococcus. Only the history may lead one to suspect the unusual origin of the infection. . . . Of course conclusive direct evidence can only be obtained by bacteriological examination."

No instance was found in the literature of a chronic circumscribed abscess in the cortex of a long bone, following typhoid. The author reports a case in which the patient, during an attack of typhoid, struck her left forearm against the edge of an iron bed. A year later a roentgenogram showed a circumscribed abscess in the cortical portion of the left ulna. When the bone abscess was opened pus was found from which was grown the bacillus typhosus.

CASE REPORT

Case No. 2888. A white woman, forty years of age, was examined September 1, 1927.

Family History. The patient's family history has no bearing on the present complaint.

Personal History. The patient had whooping cough, measles, and mumps during childhood. Ten years before the writer examined the patient, she had a "stone in the kidney" which she passed. There was no recurrence of kidney stone until about a month before her examination when she had "colicky pains" and pus in the urine. She passed another stone and was relieved of the pain. Five years before her examination she had been treated for "fallen stomach".

History of present illness. In July, 1926, the patient had typhoid fever and was confined to her bed for four weeks. At the end of the second week she had a positive Widal reaction. The patient was up and about for three weeks when she had a relapse and was in bed for thirty-two days. For nearly a month following the relapse she was

too weak to walk alone. She gradually regained her strength and health. Sometime during the first four weeks of her illness, she struck her left forearm on the edge of the iron bed. There was some swelling of the area following the injury, but there was no discoloration and very little redness. The pain was severe at first but later it abated. The area remained tender and occasionally it was painful. Following her recovery from typhoid, in addition to the pain and tenderness in the left arm, the patient sometimes noticed "a kind of numbness" in the left leg.

Present attack. A few weeks before the author examined the patient, the pain in her left arm became aggravated. It was a stinging pain and at times was so intense that she became nauseated.

Physical examination. The patient was a fairly well developed, well nourished white woman, forty years of age. There was a slight enlargement of the left lobe of the thyroid. The axillary glands were slightly enlarged. One indurated gland was found in the left epitrochlear region. A swelling was apparent in the mid-portion of the left forearm. It was slightly tender. On pressure there seemed to be a bony swelling of the ulna.

Roentgen-ray examination. A roentgenogram of the left forearm and wrist showed an area in the left ulna, about seven centimeters above the wrist joint, in which the periosteum was elevated and the cortex thickened. A cyst-like area appeared to involve the cortex. There was no suggestion of malignant change. The remainder of the ulna and the radius were normal in appearance. The medullary cavity was not involved in the pathological process (Fig. 1-A).

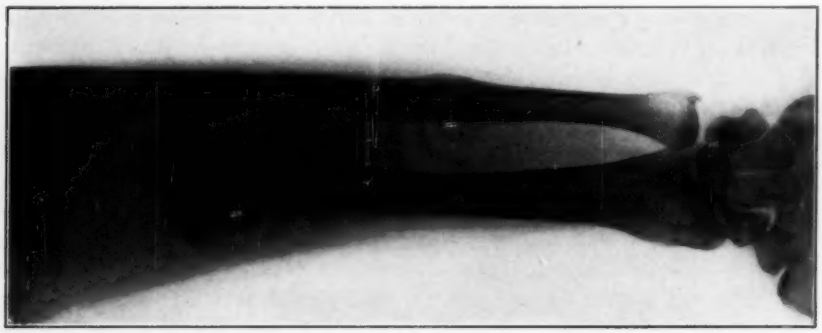

FIG. 1-A

Roentgenogram of a chronic abscess of the cortex of the left ulna which was caused by the bacillus typhosus following trauma.

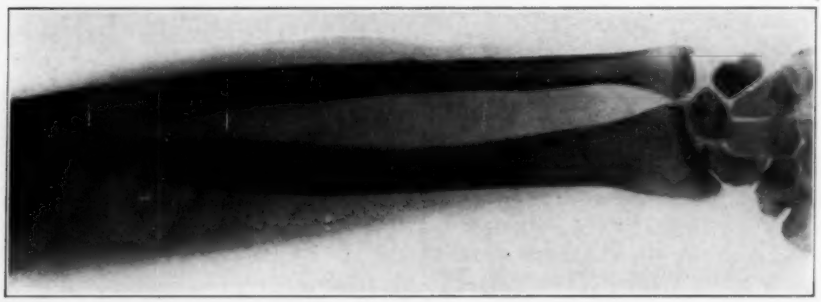

FIG. 1-B

Roentgenogram showing the condition of the left ulna six months after the removal of the chronic cortical abscess.

Operation. Under an ethylene anaesthesia, the patient was operated upon, September 15, 1927. An incision was made in the posterior aspect of the left forearm over the swelling. The periosteum was then incised over the bony protuberance. The top of the bony enlargement was cut off with a chisel. Immediately there was a flow of thick pus from the abscess cavity. Pus was put in a sterile culture tube for bacteriological study. The outer half of the abscess wall was removed with a chisel. The inner half was then curetted until it was smooth. It was observed that the bone surrounding the abscess was very hard. The wound was packed with iodoform gauze but was not sutured.

On the seventh day the pack was removed and the wound repacked. On October 29, the wound was entirely healed and was in good condition.

Bacteriological study. (Dr. Oscar B. Hunter). The bacillus typhosus was found in pus taken from the cavity of the abscess.

After-history. Since the healing of the wound, the patient has been relieved of all pain in the area of the abscess. An examination of the left forearm showed the scar to be soft and pliable. There was no swelling of the bone. A roentgenogram made March 24, 1928, showed the ulna to be normal except for a slight irregularity of the surface of the cortex at the site of the former abscess (Fig. 1-B). It is now three and a half years since the abscess was drained, and there has been no recurrence of the swelling or of the pain.

SUMMARY

1. The patient in the case being reported had injured her left forearm during an attack of typhoid.

2. Following the injury a swelling appeared on the left forearm.

3. For a year there was intermittent pain in the swollen area, the pain gradually growing more constant and more intense.

4. A roentgenogram showed a circumscribed abscess in the cortex of the left ulna.

5. The bone abscess was opened with a chisel and the cavity curetted.

6. The bacillus typhosus was obtained from pus taken from the bone abscess.

7. Six months after the bone abscess was opened, a roentgenogram showed the left ulna to be normal except for a slight irregularity of the surface of the cortex.

8. Three and a half years have elapsed, and there has been no recurrence of the abscess.

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SUBASTRAGALAR DISLOCATION OF THE FOOT

BY RODNEY F. ATSATT, M.D., SANTA BARBARA, CALIFORNIA

CASE REPORT

Mr. K. C., aged thirty-six, was riding range when his horse stumbled and fell, throwing him off. He landed with his right foot under the horse's flank and as the horse made rolling motions in an effort to get up, considerable force was exerted on the inverted ankle and foot. The patient experienced severe pain in this foot and ankle and there was immediate swelling and marked deformity. He dragged himself on his hands and knees for two miles and then was picked up by a fellow horseman and taken to Solvang from whence he was brought to the hospital.

Examination shows a marked inversion distortion of the right foot and ankle, so that the sole is looking mesially. The region of the internal malleolus is entirely obliterated by swelling which extends throughout the whole mid and fore foot. There are several bony prominences,—*viz.*, the external malleolus and the head of the astragalus on the external aspect, over both of which the skin is tightly drawn and blanched. The posterior aspect of the astragalus is also palpable.

The patient was anaesthetized, knee flexed, and reduction accomplished by first reducing the astragalocalcaneal dislocation through hyperinversion and lateral pressure over the calcis. This was fairly easily accomplished. The second step was the reduction of the astragaloscaphoid joint by means of traction and adduction of the forefoot, lateral pressure over the scaphoid, and counterpressure over the astragalar head. After some manipulation this reduction was accomplished. The foot and leg were encased in plaster from the toes to the knee with the foot at ninety degrees dorsiflexion and in the neutral position. The cast was left on for four weeks, then baking, massage, and exercises were begun. This treatment was continued three times a week for two months, after which time the patient returned to work with practically normal function except for discomfort when walking over uneven ground.

DISCUSSION

Complete subastragalar dislocation of the foot is rare, especially when unassociated with regional fractures. In this injury the astragalus remains in normal relation to the tibia and fibula while the os calcis and scaphoid are more or less completely disarticulated. The dislocation may be in one of four directions—inward, outward, forward, or backward. Associated with this disturbance of bony relations there are tremendous structural changes in the soft tissues. In the above described case it is certain that the damage to the internal and external lateral ligaments of the ankle, to the external astragalocalcaneal ligament, and to the astragaloscaphoid ligament was of grave severity.

Broca in 1852 read a paper before the Société de Chirurgie in which he collected and analyzed numerous scattered cases and established a systematic nomenclature. He considered the foot as the part dislocated and on the basis of directional dislocation, outlined the names. Baumgartner and Huguier in 1907 collected the cases reported up to that time, listed a

FIG. 1

Anteroposterior view of ankle showing complete subastragalar dislocation.

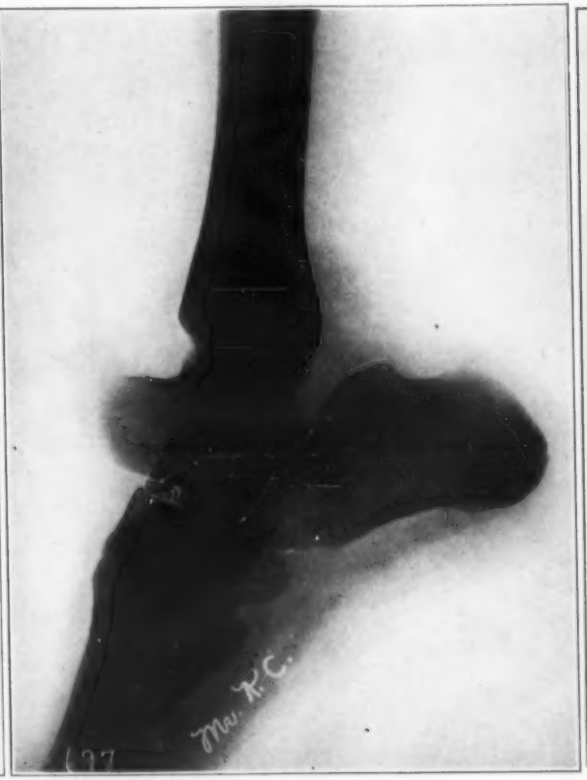

FIG. 2

Lateral view of same.

FIG. 3

Anteroposterior view of foot showing realignment of astragaloscaphoid joint.

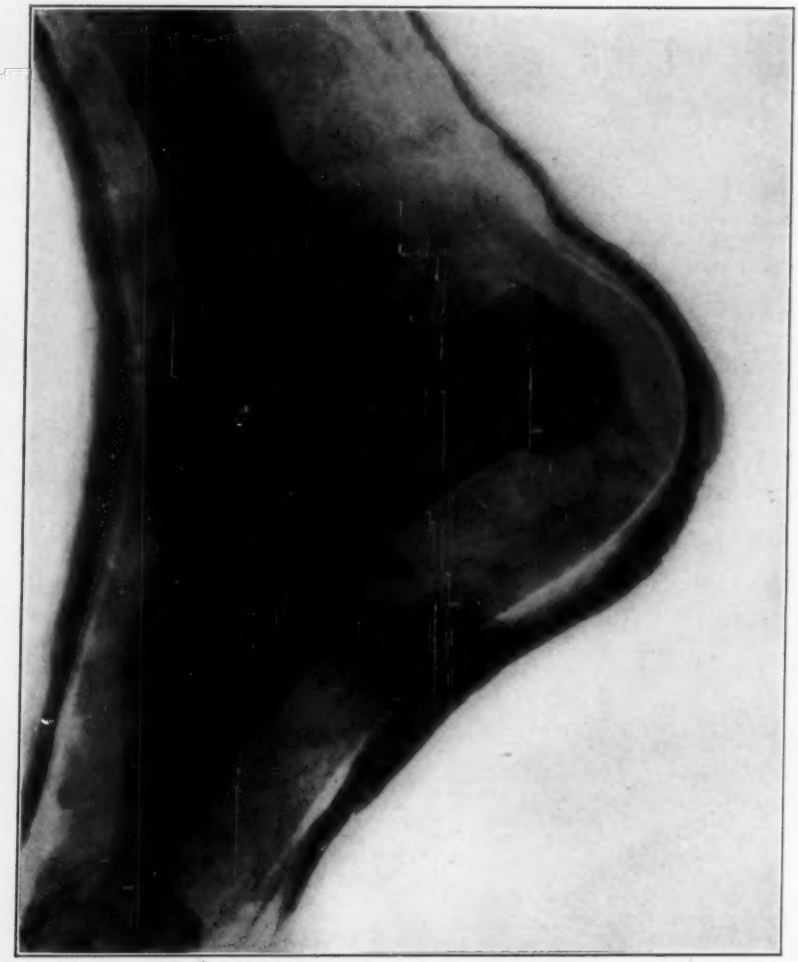

FIG. 4

Lateral view showing reposition of foot on astragalus.

total of eighty-four, and added their own to make eighty-five. Beveridge Moore in 1922 added three more cases and Bolling in 1923 added another. Search of the literature since that time fails to reveal further reports.

The treatment of this type of injury consists in attempting to produce an anatomical reposition of the elements through a reversal of the forces causing the injury; so manipulation with traction is the method of choice. These manoeuvers may be unsuccessful when ligamentous structures become caught in the reduction and may necessitate an open reduction. The fixation period need not be over four weeks, but a complete cast to the knee should be used to secure adequate immobilization.

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GAS BACILLUS INFECTIONS IN AMPUTATION STUMPS

REPORT OF THE COMMITTEE, HOSPITAL FOR JOINT DISEASES, NEW YORK, N. Y.

By a careful investigation of the causes, preventives, and therapy of gas-forming infections in postoperative amputation stumps, we have found that:

1. A possible cause is the inadequate preparation of the leg to be amputated; bacillus Welchii from the stool, a normal inhabitant of the human colon, may have been deposited about the operative site.

2. There is a possibility that the bacillus Welchii may be contained in the lymphatics of the leg to be amputated, and that the operative trauma is sufficient to light up an infection.

3. It is thought exceedingly *unlikely* that the gas bacillus is carried into the wound by any fault of the operating-room technique, or from suture material.

We believe that the type of infections occurring should be classified as two varieties:

First: A true gas-bacillus infection of either the bacillus Welchii, or a related type of organism.

Second: One of the pyogenic organisms which can produce gas.

It is believed that this second etiological factor must be given credence inasmuch as several men have reported cases where reliable laboratories failed to find the bacillus aerogenes capsulatus as the infecting organism.

The two types of patients which seem most likely to get gas-bacillus infection after amputation are either the diabetics or the arterio-sclerotics; these may be considered as one large group of those having vascular disease of the extremities. Of course, this accident may happen in traumatic cases; but we shall see how this can be avoided in a subsequent part of this report.

Since a gas-bacillus infection is a real menace in every amputation on this type of patient, the following precautions should be observed:

1. In cases of gangrene, the gangrenous area should be cultured and if the presence of bacillus Welchii is demonstrated, a prophylactic injection of gas-bacillus serum should be given. The dose is two cubic centimeters, and the price is $3.00. We feel that the Board of Health of this City or State should be encouraged to prepare and market this serum.

2. A culture should be made of a bit of muscle at the site of amputation at the time of the operation.

3. The gangrenous area should be carefully covered before the patient is sent to the operating room; this cover should remain in place during the preparation of the leg for amputation, and be covered with sterile drapes so that the gangrenous area itself is never exposed in the operating room.

4. The preparation of the patient at the bedside should be done with meticulous care so that any subsequent bowel movement cannot possibly infect the leg. The person preparing the leg should go through a regular "scrub-up" technique and wear sterile gloves. It may be advisable that the patient's bowels be "tied-up" with tincture of opium for twenty-four hours before the preparation is started.

5. The site of amputation, in the opinion of some, should be mid-thigh.

6. In amputating through a thigh which has a gangrenous area below, we should consider that we are amputating through a potentially infected area. These stumps may be left open inasmuch as innumerable muscle planes and lymph spaces, which probably are carrying pathogenic organisms, must be opened.

7. It is further recommended that a guillotine amputation be done, because it is the fastest and least traumatic type.

8. In extremities which have been so traumatized that an immediate amputation is indicated, a disarticulation at the knee should be done if possible; in this way no muscle planes and relatively few fascial spaces are opened. After the patient has recovered from this, a secondary amputation may be done as desired.

9. No tourniquet should be used.

TREATMENT

Serum therapy: The prophylactic dose of serum, as has been said before, is two cubic centimeters, and this can easily be given twenty-four hours before the operation. One of the Committee, Dr. Milch, who has thoroughly investigated the polyvalent serum, feels that this prophylactic serum should be used just as freely as we use tetanus antitoxin at the present time.

The serum is used after the infection has developed by giving 100 cubic centimeters doses of the polyvalent serum every four hours until the temperature and pulse have returned to normal and the infection is under control.

The further treatment of this type of infection falls into two classes,—surgical and chemical.

The indication for surgery is a very, very wide exposure of all the affected parts, excision of the affected muscle, and possibly a higher amputation than had already been done.

Chemotherapy should not be placed as one of the effective agents. Hydrogen peroxid is valueless. Dakin's solution and potassium permanganate are better. A quinin solution was introduced by Pilcher during the War with some success, but this is not a generally accepted solution. It is used in the same manner as is Dakin's solution and is prepared in the following way:

Solution 1 is prepared by dissolving one gram of quinin sulphate in five cubic centimeters of glacial acetic acid and five-tenths cubic centimeters of hydrochloric acid.

Solution 2 is prepared by dissolving seventeen and one-half grams of sodium chlorid in water.

Solution 3 consists of one-quarter gram of thymol dissolved in fifteen cubic centimeters of ninety per cent. alcohol.

Solutions 1 and 2 are mixed, one cubic centimeter of forty per cent. formol is added, solution 3 is added, and the whole is made up to one liter by the addition of water.

NICHOLAS S. RANSOHOFF, M.D.
Chairman of the Committee.
HENRY MILCH, M.D.
I. ZADEK, M.D.

GENERALIZED POLYDACTYLISM WITH CONCURRENT SYNDACTYLISM

BY ROBERT BOOTH ACKER, M.D., SOUTH BEND, INDIANA

The following case report is presented because of the interesting anomaly described.

The patient, a laborer aged thirty-five, presented himself for treatment of a condition in no way related to his hands or feet. He is a strong, muscular individual and uses his hands and feet freely and without discomfort.

The hands have in effect three fingers and a thumb each (Figs. 1 and 2). It will be seen that the middle group in each hand is made up of three fingers fused, there being three separate tips and nails in each group.

Reference to the x-ray (Fig. 3) discloses that the bones of each syndactyl clump consist of one fairly normal appearing proximal phalanx, and a double, fused, and branching proximal phalanx with three sets, of two each, of middle and distal phalanges. The one normal appearing phalanx articulates with the third metacarpal bone, and the double, fused, and branching phalanx articulates with the fourth metacarpal and a rudimentary metacarpal springing from the outer side of the third metacarpal. This is true of both hands.

The toes (Figs. 4 and 5) also present an interesting anomaly. The effect is a six-toed foot, both right and left, the syndactyl group in each foot comprising the rudiments of three toes. The bone distribution (Fig. 6) varies. In the right foot a rudimentary fifth metatarsal articulates with the fused, proximal phalanges of the fifth and sixth toes. The sixth metatarsal articulates with the rudimentary fifth, and possibly with the fused

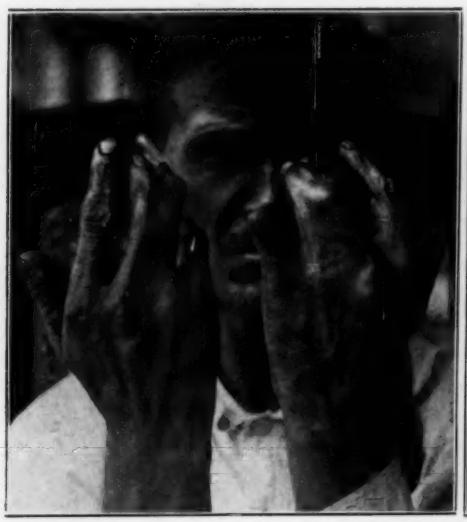


FIG. 1

FIG. 2

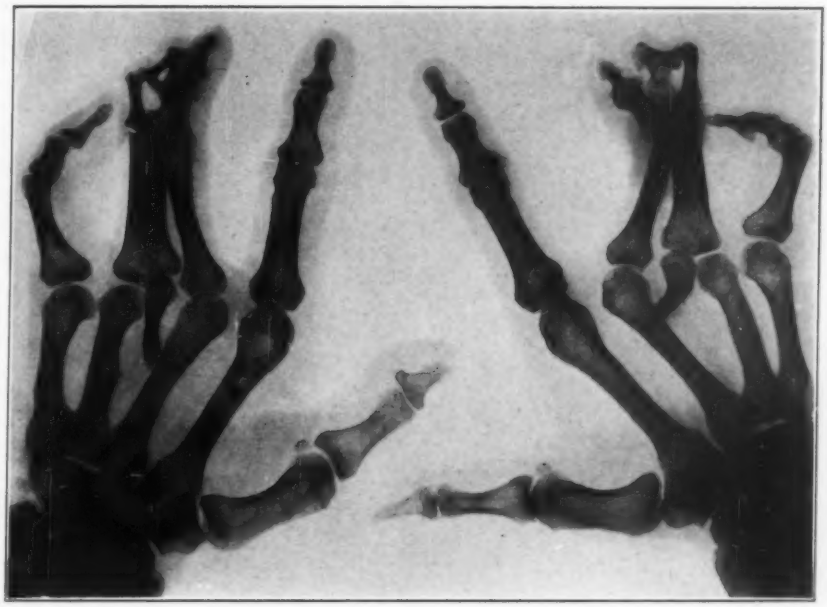


FIG. 3

fifth and sixth proximal phalanges. The left foot has a branching metatarsal corresponding to the fifth and sixth, one branch articulating with the proximal phalanx of the fourth toe, and the other branch with the fused proximal phalanges of the fifth and sixth toes. A sixth metatarsal does not articulate with a toe.

This man is able to use his hands very well. While there is a certain amount of restriction of motion in the distal phalanges,

FIG. 4

FIG. 5

FIG. 6

he is able to make a fist and handle tools with comparative ease. He is not conscious of any disability so far as his deformity is concerned. He has shipped as a sailor and handled rigging, and has even taken his turn in the stoke hold of a steamer with a coal scoop and fire-cleaning iron. He appears as a normal individual and, unless particular notice is taken of his hands, the deformity is not evident. He walks without limp and has no particular inconvenience from his feet, so long as his shoes are fitted properly.

THE ARTHROSCOPE

A New Method of Examining Joints

BY HARRY FINKELSTEIN, M.D., AND LEO MAYER, M.D., NEW YORK, N. Y.

Attending Surgeons, Hospital for Joint Diseases

During the past decade there has been an increasing interest in the exact diagnosis of joint diseases, and a consequent development of methods for accurate determination of the pathological lesion. The study of synovial fluids—chemical, bacteriological and microscopic—oxygen injection of joints with subsequent x-ray, the refinement of the tuberculin tests, the compliment fixation tests, and ultimately biopsy of the joint, have added immensely to our diagnostic armamentarium.

These efforts have not been without their reverse aspects. The writers have seen a flare-up of a joint following a biopsy, and in several instances where the biopsy revealed only chronic inflammation a subsequent synovectomy revealed the presence of tuberculosis. In at least four cases during the past year joint fluids gave negative guinea-pig reactions, although the joints later were proven tuberculous by microscopic examination. In many other instances, despite the use of all known methods, the diagnosis could not be made until an extensive exploratory operation was performed. In a study of some hundred cases of tuberculosis treated at the country home of the Hospital for Joint Diseases, the authors have been impressed by their inability to prove tuberculosis bacteriologically or microscopically in more than half the number.

In searching for improvement in methods of diagnosis, one of us devised a punch, by means of which a small bit of tissue might be removed from within the joint with a minimal degree of trauma. This instrument, however, had the obvious disadvantage of being used in the dark. It was, therefore, but a short step to conceive of an electrically lighted instrument which would permit the surgeon to view the interior of the joint and to remove tissue for examination under control of the eye. This instrument would have essentially the same construction as a cystoscope.

After several months of experimentation, two instruments have been devised; the one solely for visualization of the joint, the other for visualization combined with a device for removal of tissue.

The arrangement of the system of lenses is shown in a line drawing (Fig. 1). The technical problem involved was not new since it was closely analogous to that encountered in the deep urethra. Thanks to the researches of Dr. Joseph F. McCarthy and Mr. Reinhold Wappler, the optical problem had already been solved. By means of a peculiar objective lens the optical pupil is displaced from the center of the telescope to a point very near the periphery of the tube, thus making about nine-tenths of the front portion of the instrument available for the illuminating lamp mounting.

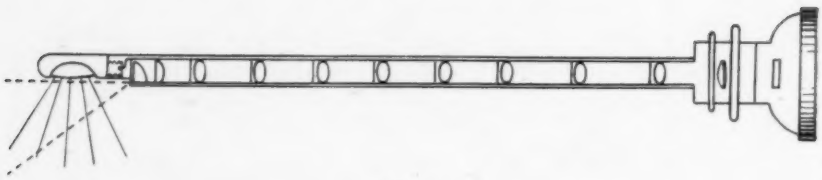


FIG. 1

Line drawing illustrating arrangement of the system of lenses in the arthroscope and the visual field outlined by the dotted lines.

This provides light in the most advantageous place for uniform and efficient illumination of the visual field. It does not increase the diameter of the telescope nor cause any irregularities along its length. The diameter of the telescope is eight French and is used in an outer sheath with large enough lumen to permit water circulation. The caliber of the instrument must be small so as not to traumatize unnecessarily, and the optical axis deflected only just enough from the direct to exclude the lamp from the visual field. The operator sees the tissue in front of the instrument, not at right angles to the instrument, as in the older type cystoscope.

Figure 2 is a photograph of the visualizing arthroscope. It shows the sheath with the two irrigating tips—one for inflow, the other for outflow—, the eye piece, the electrode for attachment of wires leading to the battery, and the electric light at the tip of the instrument.

The operating instrument (Figs. 3 and 4) is equipped with an irrigating device, since the authors found that unless the joints were filled with clear fluid the tissues could not be seen distinctly. The actual removal is done by a conchitome whose form is best seen by referring to Figures 3 and 4.

Two types of sheath have been used,—one rounded as pictured in the illustrations, the other sharp like a trocar. The latter has the obvious advantage of permitting insertion without necessitating an incision but is more likely in inexperienced hands to traumatize the interior of the joint. For this reason the authors have thus far used only the blunt instrument in their clinical cases.

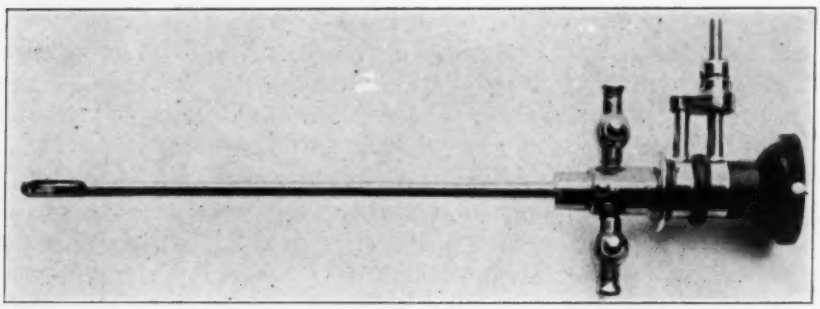


FIG. 2

Photograph of the arthroscope showing the eye piece, the attachment for the electrodes, the two irrigating nozzles, and the electric light at the tip.

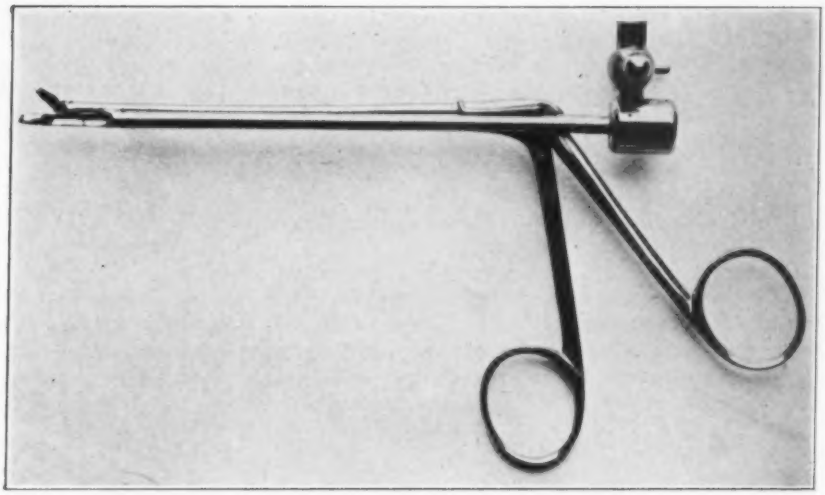


FIG. 3

Shell of the operating instrument; the eye piece and the lens attachment have been withdrawn. The conchitome at the tip of the instrument is open. When closed, the tip of the instrument is quite smooth.

Cadaver studies were made of ten bodies. A trocar was introduced into the quadriceps pouch, the joint distended with fluid, and the arthroscope inserted through the trocar. It was noted that only when the joint was moderately distended with fluid was the picture clear. An excellent view could be had of the entire quadriceps pouch, of the condyles of the femur and of the tibia, of the anterior crucial ligament, and of the menisci. Attempts were made to distend the joint with air. It was found that the visibility was not nearly as clear as with water, possibly owing to the rapid escape of the air alongside of the arthroscope. The best site for the insertion of the instrument was determined by numerous experiments. On the whole the best site is just below and to the outer side of the patella. For a view of the external aspect of the joint, however,—that is, the region of the external meniscus,—it is better to insert the arthroscope from the inner side of the joint. Flexion of the knee to an angle of 150 degrees was found to be the best all-around position for examination purposes.

CLINICAL EXPERIENCE

Thus far three patients have been examined with the arthroscope. All three were cases of chronic inflammation of the joint varying in duration from one to two and a half years. In all three there had been a synovitis causing a distention of the joint varying from one to three inches. A differential diagnosis between tuberculosis and chronic infectious synovitis had to be established.

CASE 1. Female, aged eighteen, pain in the knee and swelling for one and a half years; no other joint involved. History of right-sided abdominal pain and frequent at-

tacks of vomiting led to the diagnosis of chronic appendicitis. At laparotomy, however a normal appendix was found.

The aspiration of the joint showed the following:

Ten cubic centimeters of turbid yellow fluid; number of cells, 10,160 per cubic millimeter.

Differential count:

Polynuclears 76 per cent.
Synovial cells 4 per cent.
Mononuclears 6 per cent.
Lymphocytes 14 per cent.

Wassermann 1–2 plus, gonococcus compliment fixation negative.

The high cell count and prevalence of polynuclear leucocytes indicated an active process. The sedimentation rate of the blood, thirty-two millimeters in one hour (high normal, eleven millimeters), confirmed this view. The roentgenogram showed no lesion except a small, gouged-out area on the lateral condyle of the femur, suggestive of lues rather than tuberculosis. Guinea-pig inoculation was negative. At arthroscopy De-

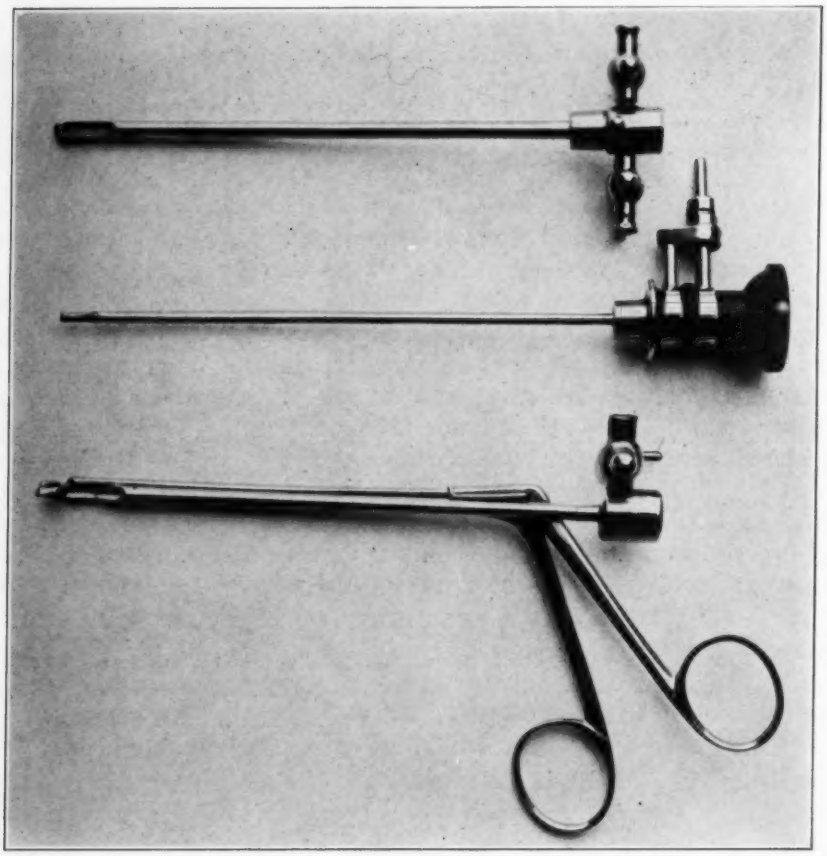


FIG. 4

Photograph of the arthroscope taken apart.
Above:—Sheath of the observation instrument,
Below:—Sheath of the operating instrument,
Middle:—Core consisting of eye piece, lens, and electric light attachment.

cember 17, 1930, a one-half inch incision was made over the outer aspect of the joint to permit insertion of the visualizing arthroscope. A remarkable picture was seen in the quadriceps pouch. Numerous delicate bands were visible, running from the anterior to the posterior wall of the pouch and resembling the chordae tendineae of the heart. The synovial membranes showed no ulcerations at any point. By gently thrusting the arthroscope downward a clear view was had of the condyles of the femur and the tibia. No erosions of the cartilage were found at any point. The operating arthroscope was then introduced. It was much more difficult to see with this instrument, owing to the fact that irrigation with the instrument then used could not be maintained. Several bits of synovial membrane were removed for examination purposes. These were reported as showing chronic inflammation. A synovectomy was therefore performed January 4, 1931. Despite the negative guinea-pig inoculation and the negative results from the arthroscopic examination the synovial membrane, when thoroughly examined, showed several areas that were definitely tuberculous.

COMMENT

This case taught us the shortcomings of our instrument and the necessity for developing the technique of arthroscopy. It also emphasized the uncertainty of the guinea-pig inoculation, the Wassermann reaction, and the roentgenogram, and the importance of a thorough examination of the synovial membrane.

CASE 2. History of pain in the knee, of one and a half years' duration. Examination showed marked distention of the right knee, moderate tenderness, slight redness. Extension to 170 degrees, flexion to 120 degrees.

Arthroscopy. March 4, 1931. A one-half inch incision was made over the outer aspect of the joint just below the patella. The joint was filled with saline, a clear view was then had of the quadriceps pouch and of the condyles of the femur and tibia. Numerous adhesions were found in the pouch and a number of erosions of the cartilage. The specimens of the synovial membrane which were removed showed tubercles. The diagnosis was confirmed at operation March 11, 1931, and a fusion of the knee was done.

CASE 3. D. DeM. Four years previous to admission patient had tuberculosis of the left elbow requiring extensive resection. The wound remained healed and the elbow had caused the patient no inconvenience. For several months the patient had noted a swelling of the right knee. Recently he developed a purulent discharge from the calf just below the knee. Examination showed marked distention of the right knee which measured three inches greater than the left. Over the anterior aspect of the tibia were two discharging sinuses. X-ray picture showed irregularity of the external condyle of the tibia and numerous areas of rarefaction. Although the diagnosis in this case was obviously tuberculosis, arthroscopy was done as a preliminary measure before fusing the joint. On puncturing the knee a large amount of pus escaped. After the joint had been irrigated through the arthroscope, an excellent view of its interior was obtained. Numerous erosions of the cartilage were found, confirming the diagnosis of tuberculosis. The specimens of synovial membrane removed also showed tubercles.

In the use of the arthroscope in the operating room several precautions are necessary to preserve asepsis. First, the operator must wear a sterilized all-over mask which prevents contact of his face with the instrument. It has been suggested that sterilized plain glass spectacles also be used so as to keep the operator's eye from contact with the arthroscope but this is not necessary if care is taken not to touch the eye piece with the gloved hands.

Second, the instrument must be sterilized even more carefully than the ordinary cystoscope. The sheath is boiled;—the core containing the optical parts is kept in oxycyanid of mercury one in 200 parts for fifteen minutes, or in a formalin cabinet for twelve hours, and then washed in sterile water.

Some fear has been felt that the irrigation of the joint and the introduction of the arthroscope might produce a severe reaction. For this reason in the first two cases, operations on the joint were postponed for some time following the arthroscopy so as to observe the behavior of the joint carefully. In neither case was there the least reaction from the arthroscopy. There was no elevation of temperature, no increased tenderness of the joint, nor did the patient suffer any pain. In the third case the operation was performed immediately after the arthroscopy without any apparent ill result.

SUMMARY

In this preliminary report a method of direct visualization of the joint and removal of specimens of tissue by means of an arthroscope has been presented and three clinical cases reported in which this method has been used. Though the value of the method is at the present time problematical, our experiences, inadequate though they are, have encouraged us in the belief that this instrument will enable more accurate diagnosis of joint lesions than any method previously devised.

The *Journal* also acknowledges receipt of another article on Arthroscopy, an experimental cadaver study, written by Dr. Michael S. Burman, a Scholar of the Henry W. Frauenthal Travel Scholarship. This article will appear in the October issue of the *Journal*.

Editor.

SKELETAL IMMOBILIZATION IN DIFFICULT FRACTURES OF THE SHAFTS OF THE LONG BONES*

A New Method of Treatment as Applied to Compound Comminuted and Oblique Fractures of Both Bones of the Leg

BY HORACE C. PITKIN, B.S., M.D.,
AND HARRY M. BLACKFIELD, A.B., M.D., SAN FRANCISCO, CALIFORNIA

The treatment of compound comminuted and oblique fractures of the tibia and fibula is a difficult problem under the best conditions. Necessity fostered the device here presented to meet the conditions found in many busy hospitals.

THE METHOD

Upon entry the patient is given immediately a subcutaneous injection of tetanus and mixed anaerobic antitoxin. In the operating room, surgical anaesthesia is obtained by 200 milligrams of neocain crystals dissolved in four cubic centimeters of spinal fluid and injected into the spinal canal through the third lumbar interspace. We have used spinal anaesthesia in all our cases because of the perfect muscular relaxation obtained. An Esmarch bandage is wrapped about the leg from the toes to the mid-thigh. The distal portion of the bandage is removed and the proximal portion left as a tourniquet. We have had the greatest success with this type of tourniquet; it gives a dry surgical field and also massages away oedema and fluid hematoma from the site of

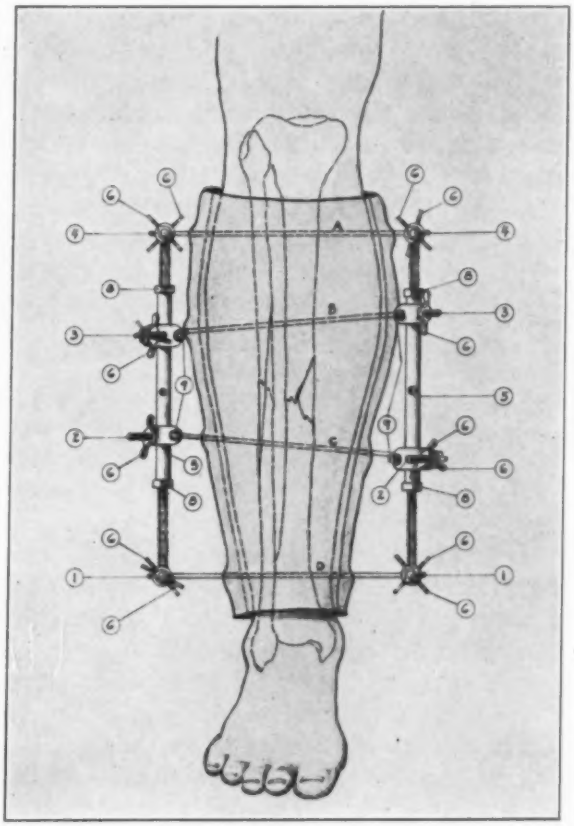


Fig. 1

Right leg with pins, turnbuckles, and cast in place.

*From the Department of Surgery, University of California Medical School, San Francisco.

fracture. The limb is prepared from the toes to the thigh by shaving, cleansing with green soap, alcohol, and ether, and painting with five per cent. picric acid. The limb is encased in sterile stockinet.

Pins *A* and *D* (Fig. 1) are inserted in the following manner: a stab wound is made on the mesial surface of the leg; a hole is drilled through the tibia at right angles to the long axis of the shaft; a steel pin is driven through the drill hole, making its exit from a stab wound on the lateral surface. A special turnbuckle appliance is attached to the ends of the pins by arms *1* and *4*. By means of the turnbuckles *5* the fragments are brought to length. Pins *B* and *C* are inserted as were *A* and *D*, except that they are not placed parallel, but are placed at an angle to prevent rotation and slipping of the fragments upon the pins. Arms *2* and *3* then are applied to the pins *B* and *C*. The stockinet is incised over the compound wound, a careful débridement is done by sharp dissections, and the fragments are exposed. The fragments are placed in anatomical position by means of turnbuckles *5* and wing nuts *6*. The apparatus is locked in position by the nuts *8* and set-screws *9*, and the stability of the fracture is tested by elevating the leg to a height of two feet and allowing it to drop forcefully upon the table several times. When stability is assured, the wound is closed by interrupted sutures, without drainage. If it is impossible to close the wound, a vaselin-gauze dressing is applied; otherwise dry dressings are used. Sterile sheet wadding, is applied sparingly, followed by a simple cylinder of plaster that includes both ends of all four pins, but *does not include the knee and ankle joints.* The tourniquet is removed, and with the hardening of the plaster the turn-buckles are removed also.

AFTER-CARE

Upon leaving the operating room, x-rays are taken to check the position so that corrections may be made if necessary. The leg is elevated in a sling for two or three days to prevent oedema. White blood cell and differential counts are done daily for three days, but the wounds are not dressed unless the temperature and blood count give evidence of gross infection. If there is evidence of minor infection, continued bed rest and elevation of the limb are enforced. If dressings are necessary, they are done in the operating room under strict operative technique.

After the cast dries, the pins are cut off flush with the cast and the whole cylinder is wrapped with one or two additional turns of plaster. The patient is allowed up in a wheel chair as soon after the third day as he desires, provided the temperature and blood count are normal. If there are no complications, the patient is allowed up on crutches as soon as possible,—usually the seventh to the tenth day. Full weight-bearing upon the injured member is allowed and even encouraged as soon as the patient desires, usually from the seventh to the twenty-first day.

Usually, at the end of the second or third week the patient, walking with the aid of crutches, is discharged from the hospital. In six to twelve

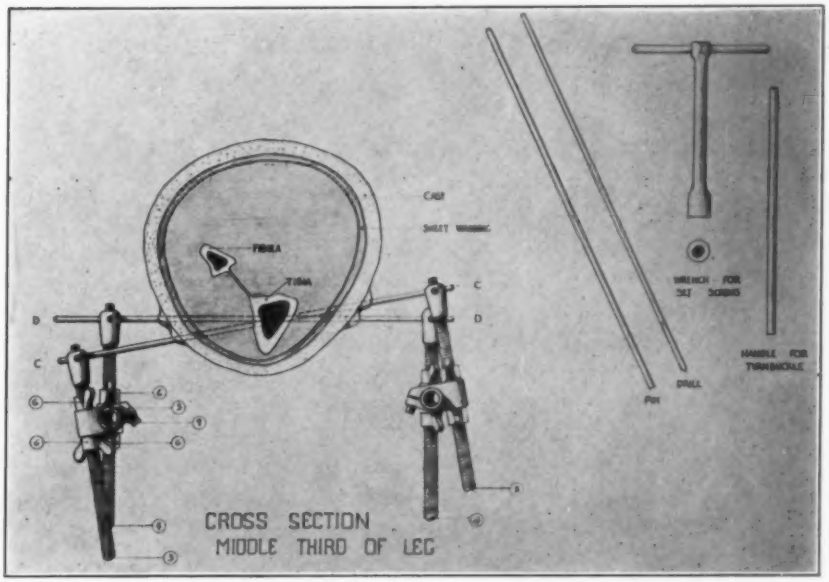


FIG. 2

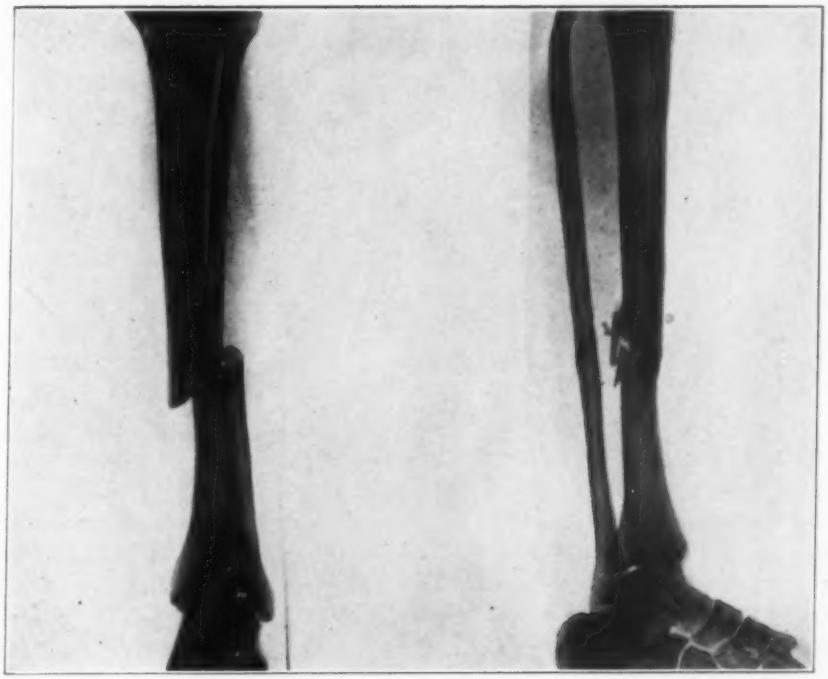


FIG. 3
Case 11 before reduction.

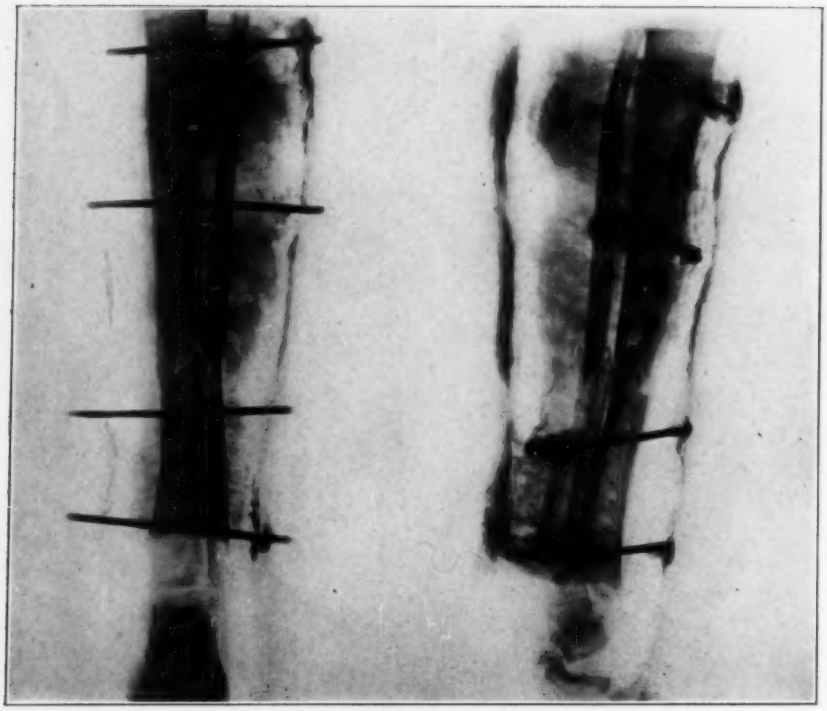


FIG. 4
Case 11 after reduction.

FIG. 5
Case 11 at thirteen weeks.

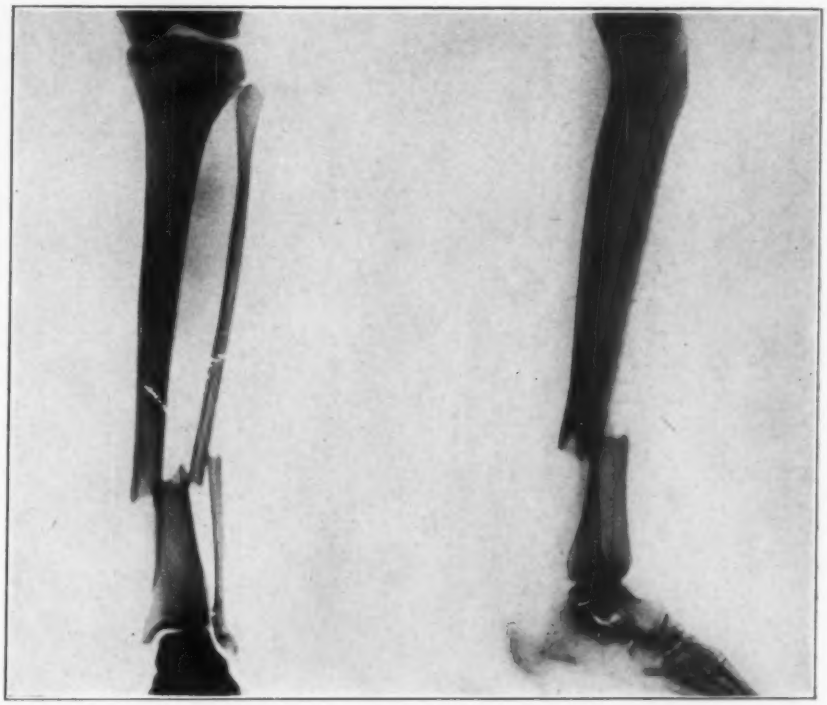


FIG. 6
Case 12 before reduction.

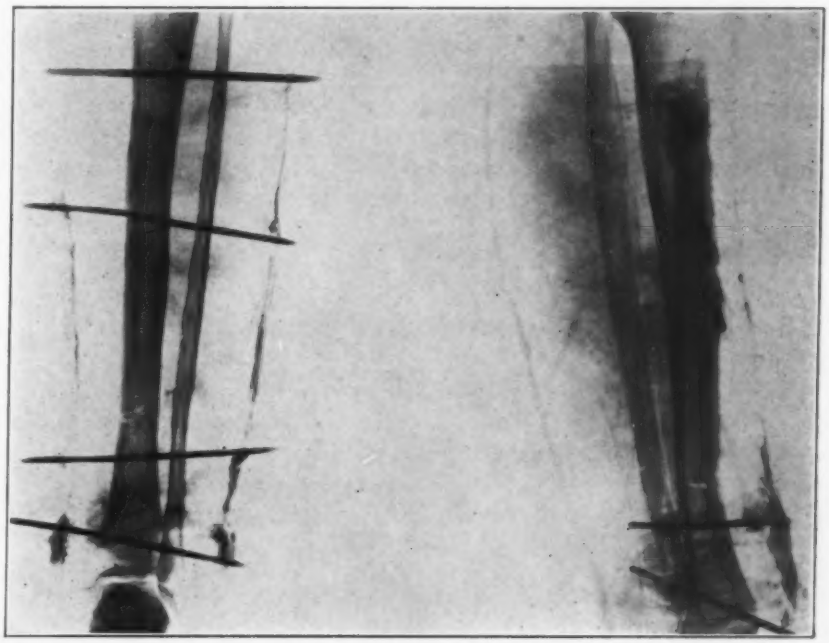


FIG. 7
Case 12 after reduction.

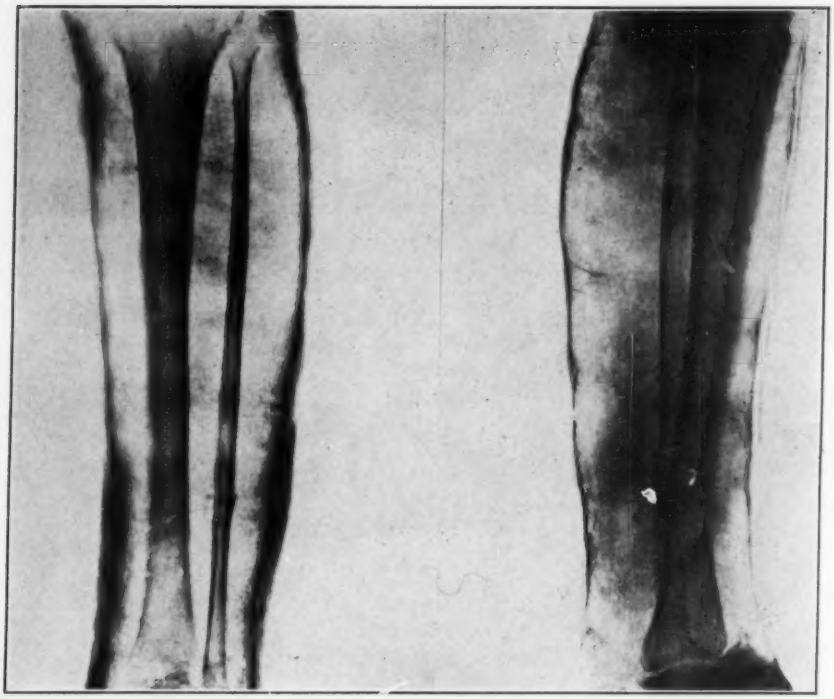


FIG. 8
Case 12 at eleven weeks.

weeks firm callus will be seen upon x-ray examination, and the cast and pins are removed. This is done in the operating room where the pin holes are syringed through and through with tincture of iodin. An Unna's paste boot is applied to the leg and foot and over this is placed a Delbet walking plaster splint, which is worn until union is complete. As no joints have been immobilized, no form of physiotherapy is needed.

CONCLUSION

In the past year, twelve cases of severe fracture of the tibia and fibula have been treated by this method. The results to date not only justify the continuance of this routine but, in terms of hospital stay, anatomical and functional results, temporary and permanent disability, and comfort to the patient, compare favorably with those expected in simple fractures of these bones. Twelve cases warrant neither a formal article nor an end-result study; these we will reserve until after a larger experience.

A SIMPLE WIRE PIN SKELETAL TRACTION APPARATUS

BY SAMUEL S. MATHEWS, M.D., LOS ANGELES, CALIFORNIA

Attending Orthopaedic Staff, Los Angeles County General Hospital

Bearing in mind the advantages of a small pin in skeletal traction, the writer feels he has worked out a more simple apparatus than that developed by Kirschner.* The apparatus has four essential parts: a simple hand brace; a saddle made of spring steel, at the ends of which are two set screws; a compressor or clamp; and a drill, made of twenty-eight gauge piano wire, which acts as a pin.

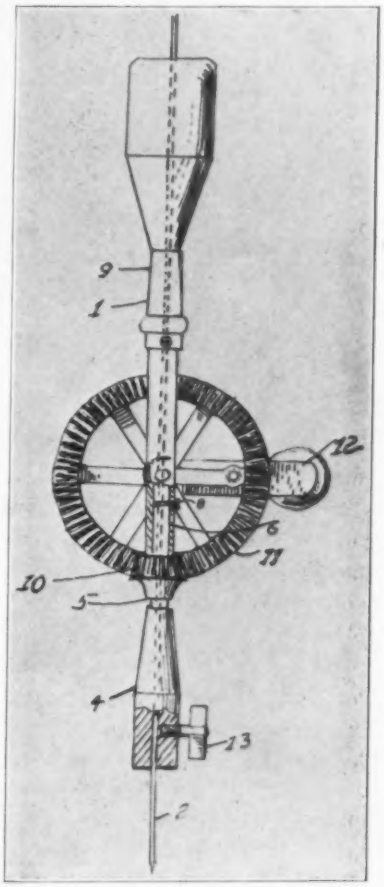


FIG. 1

APPARATUS

The brace is a simple hand brace with the rotating hollow shaft *6*, to which is secured the chuck *4* with a central bore, the size of the drill. The drill *2* is adapted to pass through the longitudinal bores of the chuck, stem, and handle and is secured by the set screw *13*. This set screw obviously regulates the projection of the drill.

The saddle *2* (Fig. 2) is a semicircular band of spring steel, the intermediate body (*7*) of which is relatively thinner in comparison with the enlarged ends (*8* and *9*). The enlarged portions are both provided with socket portions (*10*), at one end a transverse slot *11* and at the opposite the transverse bore *12*, both enlarged, are also transversely bored and screw-threaded (*13*), and screw members *15* are received within said taped bores. These screw members are centrally bored and fluted. (See Figure 2.)

The compressor *1* (Fig. 2) is formed of relatively stiff material, semicircular or U-shaped, one end of which is provided with a compressor screw *5*, while the opposite end carries an inwardly tapered pin *10*.

The drill *17* is a twenty-eight gauge piano wire with a drill point on the end.

*The writer has been unable to obtain Kirschner's original article.

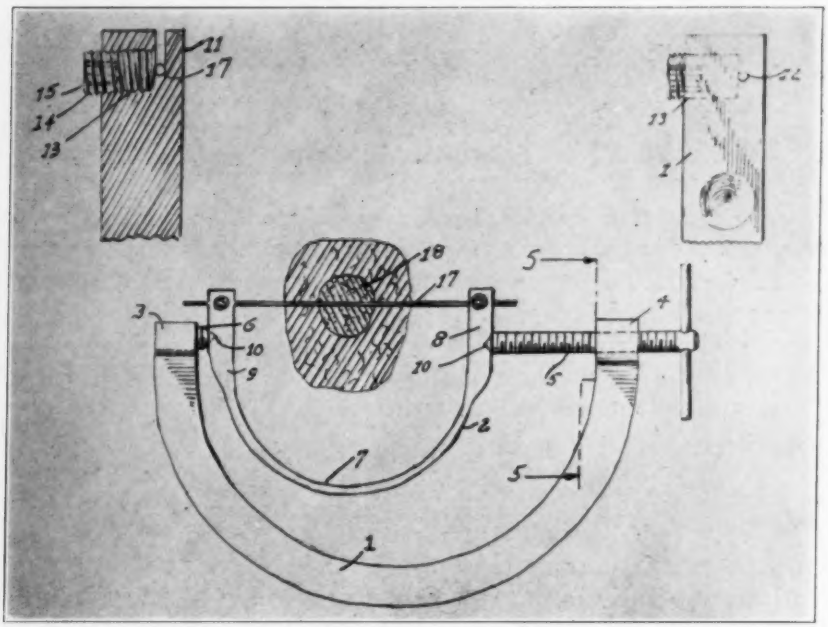


FIG. 2

OPERATION

After the drill *17* has been passed through the bone *18* by means of the simple hand brace, alcoholic dressings are applied and held snugly in place by large rubber washers, which are pierced by the drill. These rubber washers also keep the pin from working back and forth. The saddle is then brought into place by passing the drill through the transverse hole in one end and into the transverse slot on the other, and then placed in the confines of the compressor. The compressor screw is then turned so as to compress the saddle which, as has been stated before, yields for this purpose. The set screws at each end of the saddle are then tightened against the drill and the compressor screw is then released. This leaves the drill under considerable tension. Practically any degree of tension desired within a given range may be obtained by the manner just stated. On removing the pin, one end is cut close to the skin edge with sterile wire cutters and the remaining part drawn out through the wound.

CASES

The pin has worked with success in the treatment of bad fractures of the femur, the pin having been passed through the condyles or upper end of the tibia; in the treatment of fractured os calcis, after the method described by Böhler[1]; in the treatment of fractured humerus, with the pin through the olecranon; and in the treatment of comminuted fractures of

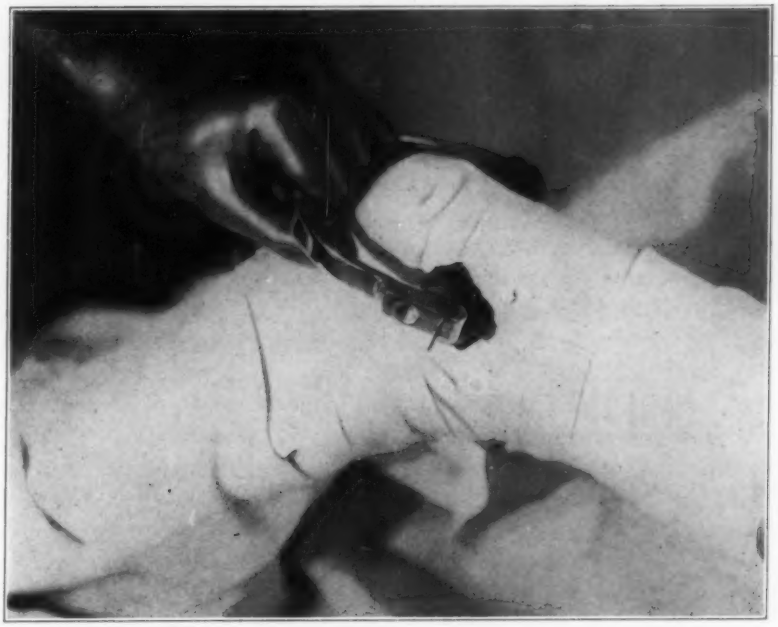


FIG. 3

Shows apparatus in place with the pin through the condyle of the femur. Note the thick rubber washers between saddle and dressings.

the tibia, with the pin in the os calcis. So far we have not encountered any appreciable reaction of the soft parts or bone.

CONCLUSIONS

Because of the simplicity of the apparatus and the fact that it requires no further attention when once in place, we feel that it has a distinct advantage over the Kirschner apparatus.

1. BÖHLER, L.: Diagnosis, Pathology and Treatment of Fractures of the Os Calcis. J. Bone and Joint Surg., XIII, 75, Jan. 1931.

A ROTARY BONE FILE

BY JOSEPH I. MITCHELL, M.D., F.A.C.S., MEMPHIS, TENNESSEE

Pegs of autogenous bone may be preferred in bone-grafting operations to nails or screws of heterogeneous material. The latter are at times employed, because of the technical difficulties encountered in the preparation of the autogenous pegs. Human bone is brittle and, when the dowel instrument is used to shape the pegs, the narrow strips of bone are frequently broken. The process of making the pegs or dowels by hand, using a bone-cutting forceps or file, is tedious and time-consuming. In addition the amount of bone which can be obtained safely from one area is relatively small. The rotary file or rasp herein described was devised to overcome these difficulties in the preparation of autogenous pegs with which to fasten the massive onlay bone graft to the fragments of an ununited fracture. The same instrument may also be used to prepare pegs of any size required, in the surgical treatment of recent fractures, or other orthopaedic procedures in which a bone peg is necessary. The file has been in routine use at the Dr. Willis C. Campbell Clinic for four years and has proved to be durable, simple, efficient in operation, and easy to sterilize.

The rotary file (Fig. 1) consists of a cylindrical disc of steel, one and one-quarter inches in diameter and one-quarter inch in breadth. The outer surface of the disc is serrated by a succession of raised, sharp-edged blades and the file is mounted centrally upon a mandrel, the end of which is adapted to the chuck of an electrically operated surgical saw. In order to determine the proper size to which the pegs should be filed, a gauge is necessary. A gauge (Fig. 2) which is sufficiently accurate for practical purposes may be made by drilling a series of holes of graduated size in a flat strip of aluminum. The ordinary mechanical twist drills are chosen for this purpose.

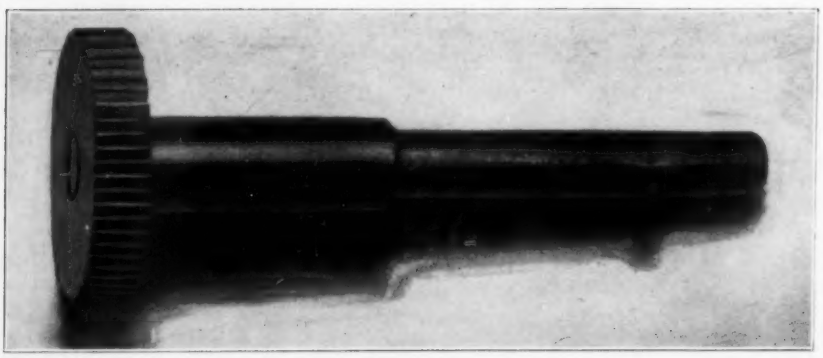


FIG. 1
Rotary bone file.

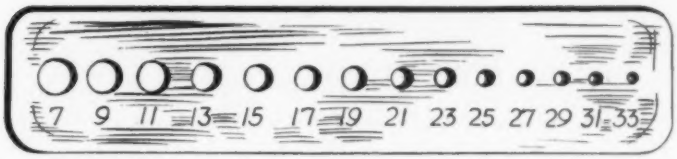


FIG. 2

Metal gauge with holes of graduated size. (Illustration one-half size.)

The technique of preparing the pegs for a bone-grafting operation is as follows: After the transplant has been removed from the tibia, another section of bone is cut with the motor saw. This strip should be one-eighth of an inch in width, should include the entire thickness of the bone cortex and may be as long as desired. If many nails are required, it is usually possible to remove a second or third strip. The bone is divided into segments according to the length desired for the nails; as a rule, the pegs should be long enough to pass through the transplant and both cortical layers of the recipient bone. The rotary file is placed in the motor which is held on the instrument table by an assistant. The surgeon grasps one of the bone fragments firmly by a clamp at each end and places it in contact with the revolving file. By moving the bone to and fro the blades quickly and evenly grind down its surface. It is not necessary to make the peg cylindrical, because the snug contact of a square peg in a round hole gives sufficient stability. However, the peg must correspond accurately to the size of the hole into which it is to be fitted; the size is determined by testing the peg in the gauge. From experience it has been found, that to fit snugly in the drill hole in the bone, the peg should enter readily into the hole in the metal gauge made by a drill two sizes larger than that used in the bone. For example, twist drill No. 19 is a convenient size for the average medium-sized peg; the hole in the gauge with which this corresponds is that made by the No. 17 drill. In a similar manner, pegs may be made to conform to holes made by large or small drills. The duration of the operation may be materially shortened if two surgical teams work simultaneously, one exposing the site of the pathology and the other removing the graft and preparing the nails.

A SPINAL ANAESTHESIA CARRIAGE

BY EUGENE C. BECK, M.D., NEW YORK, N. Y.

The carriage is designed to maintain the shock position assumed by patients operated upon under spinal anaesthesia from the time they leave the operating table until they are placed in a similar position in bed. The necessity of this position, both during the operation and after the patient has returned to his bed, is recognized by all. However, no provision has been made, heretofore, to maintain this position in transporting the patient from the operating room to his bed. It is now not necessary to disturb this position from the moment the anaesthetic is injected into the spinal canal until the complete disappearance of all the effects of the anaesthetic, hours later. We feel that maintaining this position even during the transportation of the patient from the operating room is an important factor in decreasing the untoward symptoms one occasionally sees following a spinal anaesthetic.

A further use for this carriage is presented in those hospitals where all patients are first received in an emergency ward and then later transferred to their respective wards. Any of these patients suffering from shock, who must be transferred for some reason, can thus be moved in more safety than on an ordinary stretcher, simply because their position is not changed in transit.

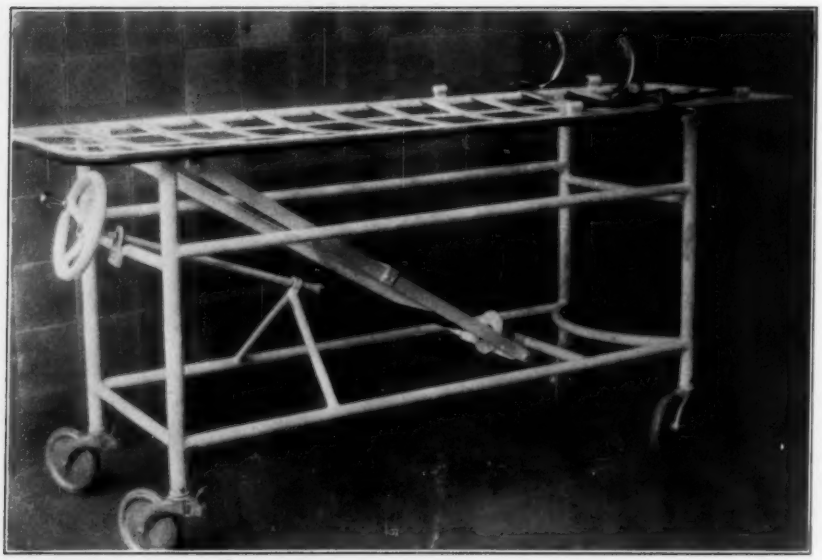


Fig. 1

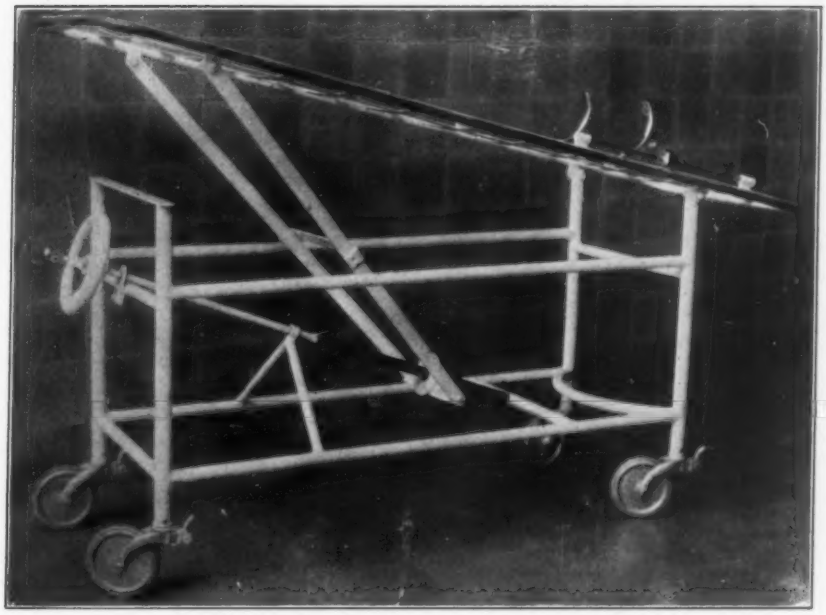


Fig. 2

The carriage, as shown by the photographs, is mounted on four rubber-tired wheels, all fitted with brakes. Its top is fitted with bumpers and equipped with adjustable and removable shoulder brakes. The foot of the stretcher is easily elevated to almost any degree desired by means of a screw crank which is placed at the foot of the carriage. The accompanying illustrations show carriage with and without top elevated. The carriage has been tested, and it has been found that the elevation of the foot of the stretcher will lift 800 pounds.

The top, which is made of slated metal, is not removable from the carriage. This type of carriage, with screw attachment, is far better than the type that is equipped with a ratchet, for when the carriage, with the foot elevated, is pushed into the elevator by inexperienced orderlies, the slightest bump or jar would release the ratchet quite readily.

This carriage is now being used at the Hospital for the Ruptured and Crippled, New York.

A SIMPLE MODIFICATION OF PUTTI'S SPLINT FOR THE EARLY TREATMENT OF CONGENITAL DISLOCATION OF THE HIP

BY G. KENNETH COONSE, A.B., M.D., COLUMBIA, MISSOURI

Department of Orthopaedic Surgery, University of Missouri

In October 1929, an article was published by Prof. Vittorio Putti of Bologna, Italy, in *The Journal of Bone and Joint Surgery* on the "Early Treatment of Congenital Dislocation of the Hip" (XI, 798). His method consisted of gradual abduction of both lower extremities in a portable splint. The results in children under two years of age were reported as excellent.

We have modified the original splint to combine traction with abduction and have found it to be a great deal more satisfactory in every way. Skin traction is obtained with adhesive in the usual fashion. The spreader rope is brought over a large wooden pulley, one on either end of the splint and fastened to a spring balance scale. One end of the rope is fixed to the balance and the other end is looped through the ring and held with a special clamp. It is thus possible to regulate the amount of tension as desired.

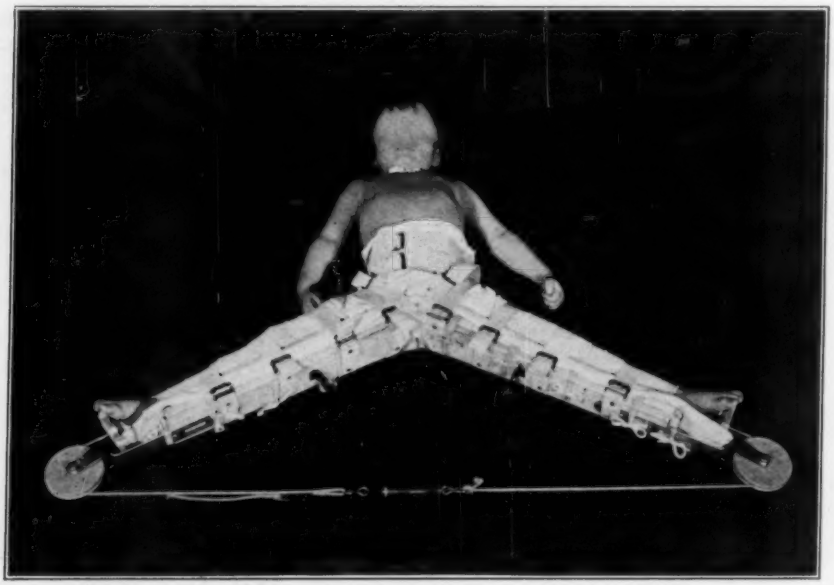


FIG. 1

Photograph of child in abduction traction splint showing spring balance scale and method of obtaining traction.

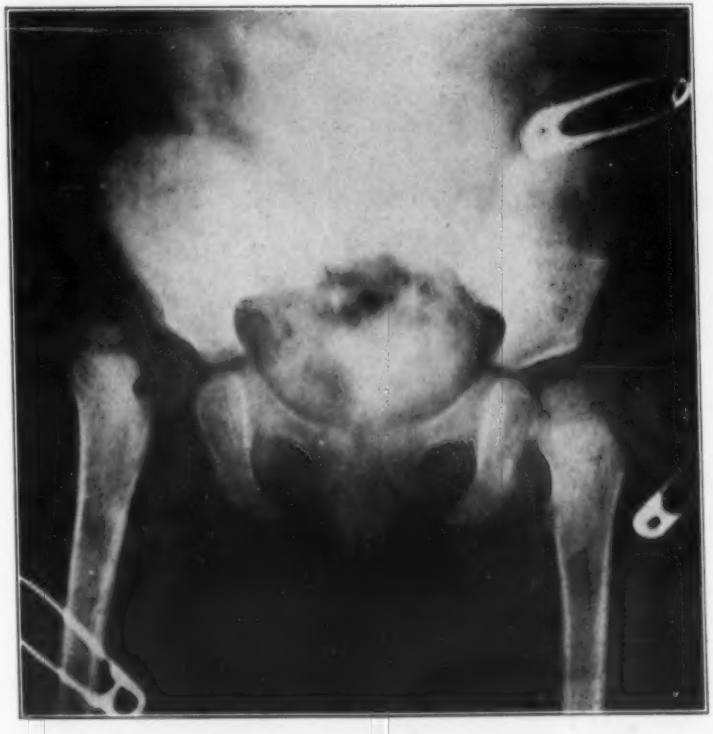


FIG. 2

Case 1. Congenital dislocation of the hip. Treatment instituted at age of fourteen months.

FIG. 3

Same case at the end of treatment nine months later. Child is now walking about.

FIG. 4

Case 2. Position after three and one-half months in Putti splint.

FIG. 5

Same child forty-eight hours after application of traction in modified Putti splint.

This traction serves not only to pull the dislocated hip downward toward the acetabulum, but also to aid in maintaining the child's position in the splint (See Figure 1). The pulleys are adjustable so that their distance from the end of the splint can be increased or diminished to suit the individual case.

At first the child's legs are placed in about twenty-five to thirty degrees of abduction and this is gradually increased at weekly intervals until reduction of the dislocated hip occurs. At the present time we combine traction with abduction in all cases. It has never been necessary to use more than eight or nine pounds of traction and as a rule five or six pounds is sufficient.

The care of these children is greatly facilitated by the use of a small, rubber-covered pad which is fitted over the splint. A small canvas girdle is also used and has proved advantageous in maintaining the proper position. By simply unfastening the buckles and loosening the traction ropes it is possible to care adequately for the skin. No difficulty from pressure has ever been experienced.

The advantage of this splint over the simple abduction type is well illustrated in the case of a child of two years with a congenital dislocation of the left hip, who was treated in the simple Putti abduction splint for four months with no improvement in the position of the head after the first four or five weeks. Five days after the application of double traction in the splint the head of the femur had been brought to the level of the acetabulum (See Figure 5). In another case under treatment in the abduction splint the child was allowed to sit up while under treatment, in spite of careful instructions to the contrary. Two months after the posterior dislocation had been reduced, an anterior dislocation of the same hip occurred. Double traction was applied and the anterior dislocation reduced in twenty-four hours and thereafter maintained.

Since combining traction with abduction we have had excellent results in all cases. As soon as the posterior and superior displacement of the dislocated hip has been overcome, the head of the femur may be allowed to approach the acetabulum as desired, by diminishing the amount of traction. If there is any tendency for the hip to revert to its former position, it is readily overcome by slightly increasing the amount of tension.

The simple abduction method, or its combination with traction, obviously offers many advantages over the various procedures necessitating the employment of anaesthetics and manipulation. Regardless of how carefully such manipulations may be done, in a closed reduction there is always the ever-present danger of injury to the upper femoral epiphysis and subsequent distortion of the head and neck of the femur with growth. Immobilization in plaster often necessitates prolonged and expensive hospitalization. Cases treated in the abduction traction splint have not as a rule required any hospitalization. In the average case it is only necessary to take an x-ray plate at monthly intervals.

This simple modification of Putti's splint is reported in the hope that it may be given a fair trial by others working with congenital dislocation of the hip in children. We believe that it is possible to successfully use the abduction traction splint up to the age of four or five years.

SUPPORT FOR PARALYZED HANDS IN CRUTCH WALKING*

BY NICHOLAS S. RANSOHOFF, M.D., NEW YORK, N. Y.

One of the difficult problems in cases of infantile paralysis is the treatment of those patients who must use crutches, and who have had such severe involvement of the upper extremities that they are unable to control their crutches. These patients usually have paralysis either of the flexors of the fingers and wrist, or of the extensors of the fingers and wrist, or a combination of both of these conditions. This paralysis may be either complete or partial.

Miss Sperling, our physiotherapist at the Convalescent Home for Hebrew Children at Rockaway Beach, New York, has devised two very simple and effective means of enabling an individual with this type of paralysis to control his crutches.

In the case of the patient who has a paralysis of the dorsiflexors of the wrist, it is necessary that the wrist be dorsiflexed to enable him to get support through the arm, and this is done as follows:

FIG. 1

The right hand demonstrates the prohibition of volar-flexion; the left hand demonstrates the completely paralyzed hand held on the crutch.

*From the Service of Dr. Leo Mayer.

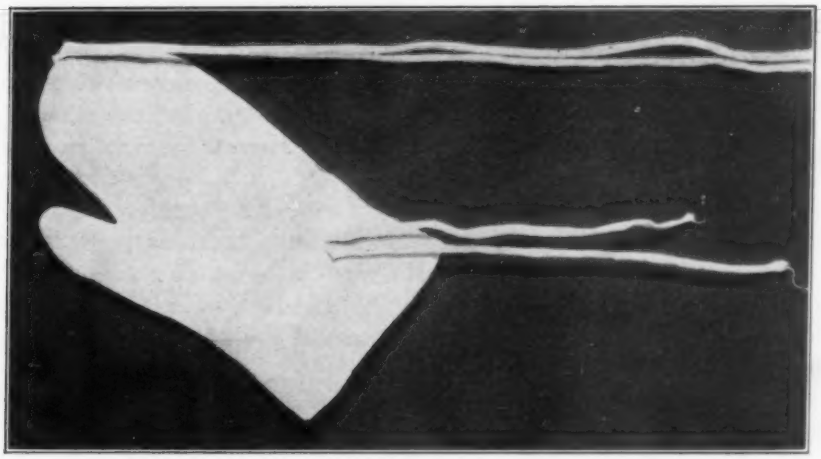


FIG. 2

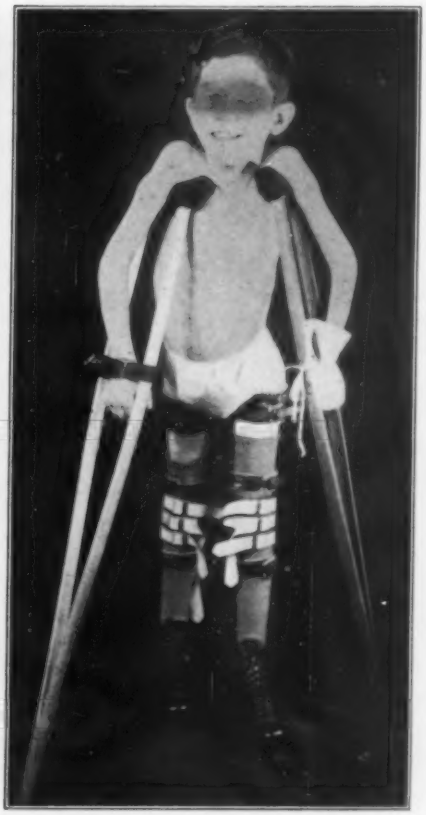


FIG. 3 FIG. 4

Demonstrates the control of the crutches.

A webbing strap, about one and a half inches wide is attached at its middle to one leg of the crutch about one inch to one and a half inches above the handle, so that when the patient grasps the crutch this webbing strap is passed over the dorsal aspect of the wrist around the other leg of the crutch and fastened with a buckle. This prevents the wrist from going into volar-flexion (See Figs. 1 and 3).

The problem of controlling the hand with either paralyzed flexors or a complete paralysis is slightly more difficult, but this difficulty also has been solved. The means of controlling the hand on the crutch is a canvas mitten with two tapes attached (as in Fig. 2). The illustration itself is the best description of the mitten; the application of the mitten, however, needs further explanation.

The mitten is put on the patient's hand and the tip, or finger band, is pulled up so that the fingers are bent around the crutch handle; this is then tied in a figure-of-eight about the wrist. The wrist tapes are then tied snugly about the wrist and these tapes, which must be of sufficient length, are brought alternately around the front and back of the wrist and are then passed around the crutch uprights and tied, so as to hold the wrist in slight dorsiflexion, and to prevent either too much dorsiflexion or volar-flexion. In this way, good control of each crutch can be given to the patient. This is well illustrated in Figures 3 and 4. This child had a complete paralysis of the left upper extremity and a paralysis of the right upper extremity involving everything except his finger and wrist flexors.

A THIGH-KNEE SUPPORT FOR COUNTERTRACTION

BY H. EARLE CONWELL, M.D., F.A.C.S., FAIRFIELD, ALABAMA

Orthopaedic Clinic, Employees' Hospital

This apparatus is useful for making countertraction on the knee and thigh when traction is being made on the leg and foot.

Fig. 1-A shows a sketch of the thigh-knee support for countertraction. *A* and *A'*, *B* and *B'*, *C* and *C'* are a single piece of band iron one-eighth of an inch thick and one and one-half inches wide. The whole piece makes up a shape similar to a tennis racquet or a triangle, with a section forming a saddle for the posterior part of the knee and thigh, as shown at *C'*.

A and A' are four and one-half inches long; *B* and *B'* are eleven inches long; *C* and *C'* are two inches long, while *C'*, the saddle, or thigh-knee rest, is four and one-half inches long. *A* and *A'* have two holes placed longitudinally for the reception of five-sixteenths inch bolts (*H*), for the fixation of *A* and *A'* to *F*.

E and *F* (a double piece of band iron) are one and one-half inches wide and one-eighth of an inch thick. This piece is bent at a right angle in the middle with a loop at one end (*R*), for the attachment to the upright *G*. This point works as a pivot. The distal end of *F* has holes placed in a circle for the reception and adjustment of the upper end of the leg rest at *A* and *A'*, as explained above.

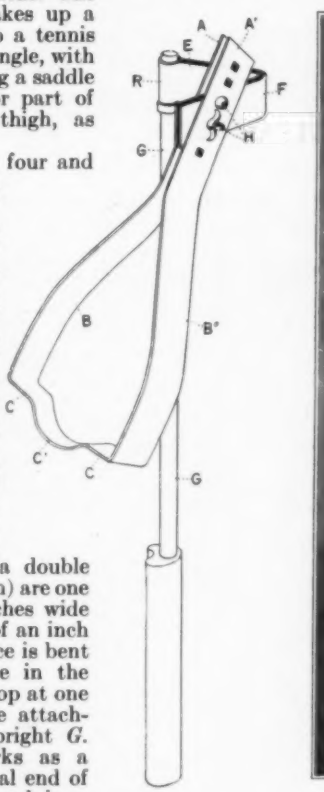


FIG. 1-A

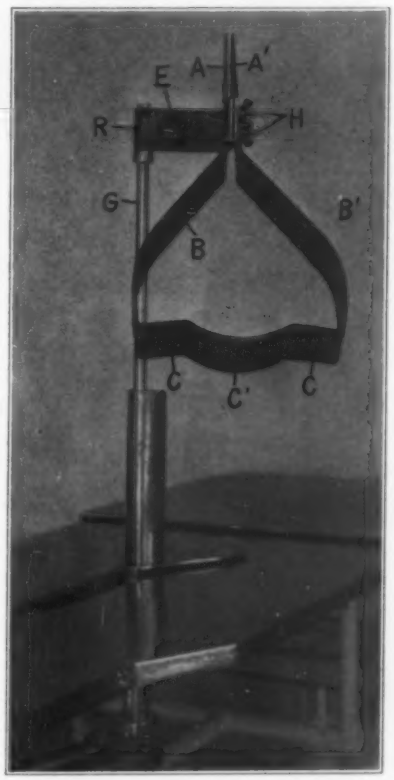


FIG. 1-B

Shows a photograph of the apparatus applied on a Hawley table.

E is four and one-half inches long and *F* is four and one-half inches long.

H shows two carriage bolts five-sixteenths of an inch long with thumb screws.

This thigh-knee attachment can be used either on the right or left lower extremity and can be raised or lowered as desired.

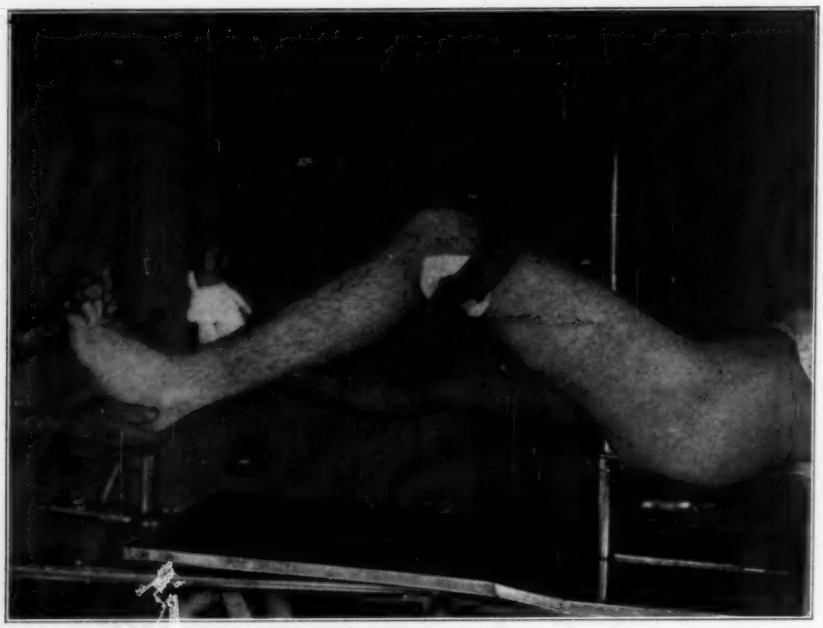


FIG. 2

Shows traction and countertraction being used. Note the felt pad where countertraction is made. This padding is important.

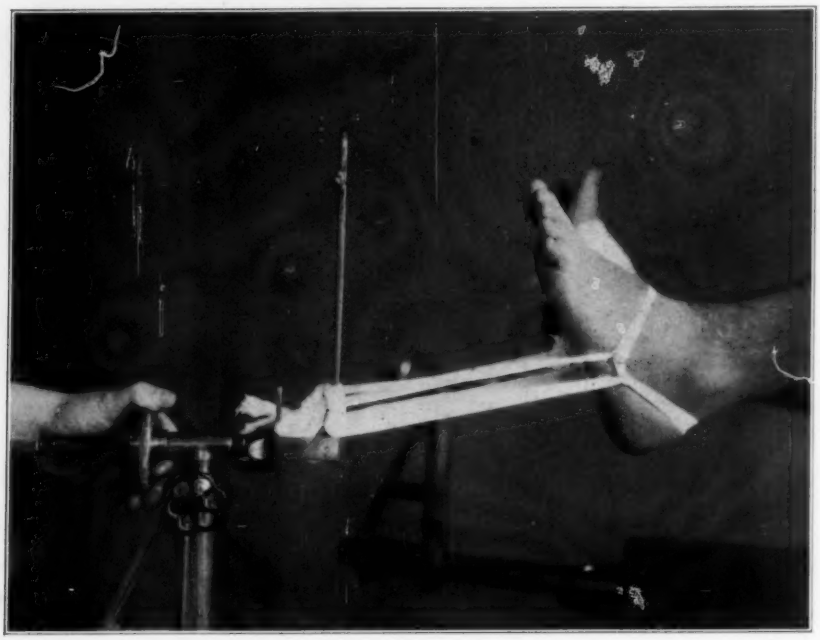


FIG. 3

Shows method of obtaining traction by applying the traction strips which are around the patient's ankle to the foot piece on a Hawley table. Traction may also be made by an assistant with aid of traction strips around the patient's ankle and assistant's body, with the assistant guiding the position of the patient's leg and foot.

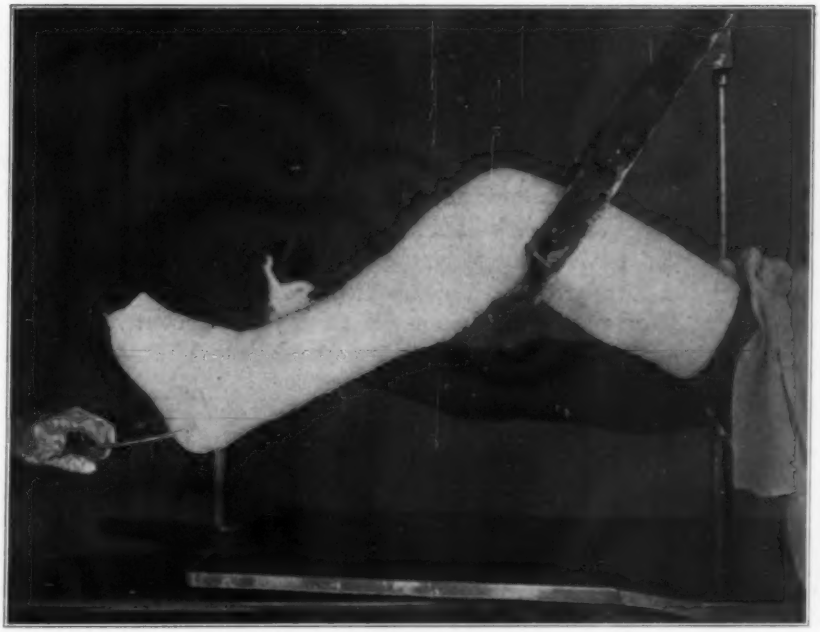


FIG. 4

Plaster cast applied and traction being made, in this case with a Steinmann pin through the os calcis. After plaster is fixed the countertraction apparatus is removed without the piece of felt and the corresponding vacant area filled with circular plaster bandages.

The apparatus:—

(a) Is easily applied and adjusted to either of the lower extremities.

(b) Can be used in any place where a fixed upright is securable.

(c) Is easily removed.

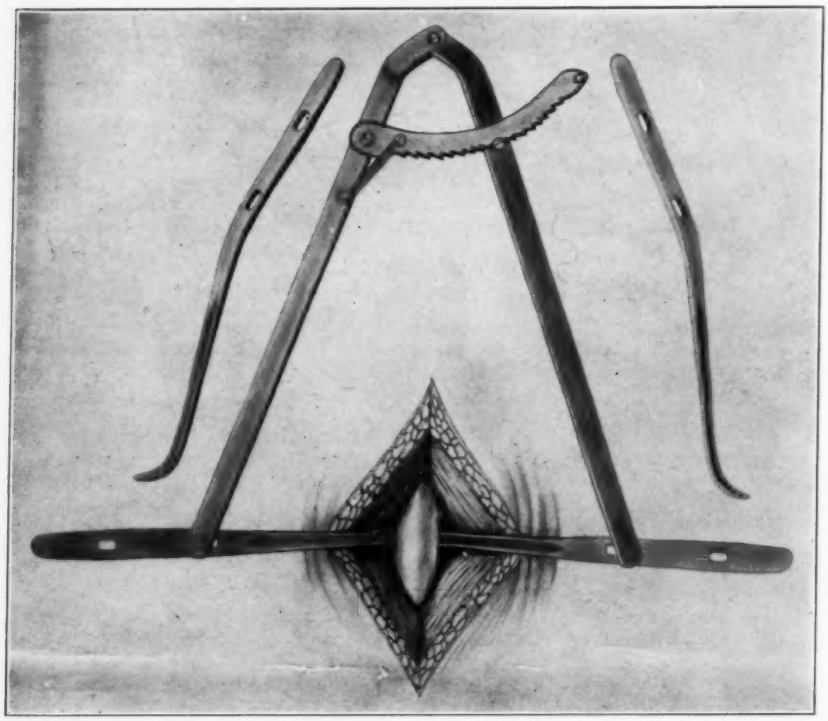
(d) Will not impair circulation if made the proper width and properly padded.

A SELF-RETAINING RETRACTOR USEFUL IN OPEN OPERATIONS ON BONE

BY P. M. GIRARD, M.D., DALLAS, TEXAS

The ordinary rounded levers used to hold back the soft tissues in open operations on bone have a tendency to rock and are consequently prone to slip and turn in the assistant's hand.

In the retractor here described the levers are grooved so that the two grooved edges fit firmly against the uneven edges of bone and remain firmly fixed at the site engaged. The shanks of the levers are bent back; so the instrument is out of the operator's way as much as possible.



The groove is also useful in Gigli-saw work, the saw being slipped around the bone through the groove which is filled with saline solution. The saw thus constantly keeps itself wet as it travels back and forth through the groove. The soft tissues on the outside of the levers are also protected. The groove is very useful in receiving the sharp end of an osteotome as it is driven through the bone, thus preventing undue dulling of the instrument and assuring protection of the soft parts.

Moreover, the arms of the self-retaining retractor do not become fatigued and relax the retractors at an inopportune moment. The assistant is thus spared the more menial part of the procedure and he can turn his attention to some of the more spectacular features of the operation.

AN ADJUSTABLE TORTICOLLIS BRACE FOR POSTOPERATIVE USE

BY M. MELVIN CLARK, B.S., M.D., ELYRIA, OHIO

Attending Orthopaedic Surgeon, Gates Hospital for Crippled Children

The apparatus herein described answers the requirements for postoperative fixation, in an overcorrected position, of the head and neck in congenital torticollis and possesses several advantages over various pieces of apparatus heretofore described.

The familiar plaster cuirass, although economical to use, possesses the disadvantages of lack of adjustability, excessive warmth in the summer months, the difficulty of maintaining cleanliness, and the occasional irritation of the skin from continued pressure or from foreign bodies—such as crumbs—that may get inside the cuirass. In addition, the cuirass does not allow the coincident use of muscle training while immobilization is being carried out.

The well-fitted Buckminster Brown brace oftentimes holds the head satisfactorily, but when less carefully fitted, the brace proves a frequent source of annoyance to patient, parent, surgeon and brace-maker alike. Frequent adjustments, requiring the services of the brace-maker or the

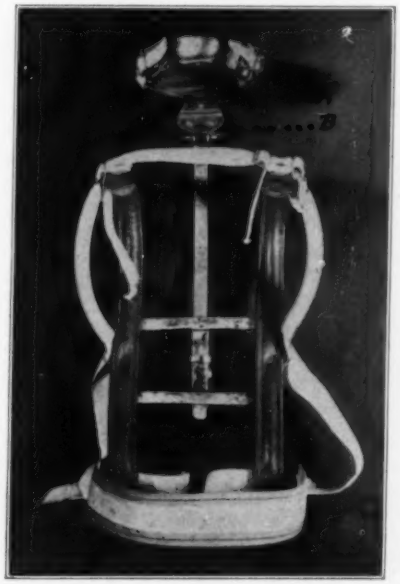


FIG. 1

Anterior view.
A. Screw to allow rotation of head.
B. Screw to allow inclination toward either shoulder.

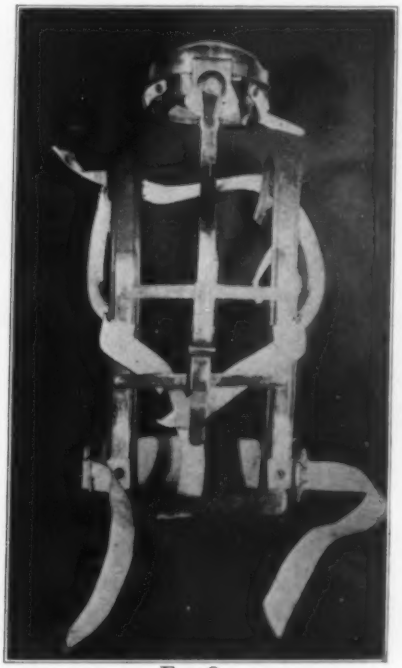


FIG. 2
Posterior view.

surgeon, are often required. The Buckminster Brown brace has to be individually fitted to be satisfactory, which means a new brace for each case treated. Another disadvantage lies in the fact that this brace does not allow a full range of overcorrection without alteration of the brace itself. Other braces that have been described suffer from similar faults.

The new torticollis brace consists essentially of a light back brace with adjustable head support. Simple screw adjustments are provided for altering the height of the head piece, for rotation of the chin, for inclination of the head toward either shoulder and for tilting of the chin. Provision is also made for changes in diameter of the head from occiput to chin, so that a few stock sizes would care for the usual size range of patients. The chin piece may be separated from the remainder of the head support for cleansing the chin and while the patient is eating, if this be desired. In the two cases in which the brace has been used, we have found very little difficulty in securing the cooperation of the child or of the parents, who are delighted to have the child treated without plaster. An added advantage has been the ease with which physiotherapy and muscle training can be carried out during the period of immobilization. Later models will have minor improvements, including a more heavily padded

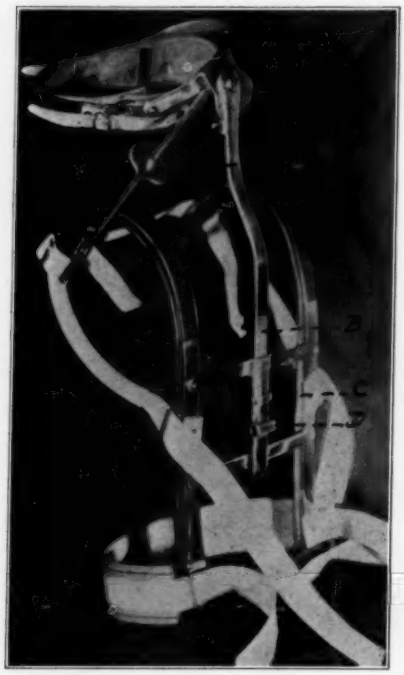


FIG. 3

Oblique view.
A. Key for adjustment.
B. Horizontal grooves for vertical adjustment.
C. Clip to maintain vertical position.
D. Box for grooved end of key to adjust eight.

FIG. 4

Lateral view of vertical post and head piece.
A. Slide to allow removal of chin piece and change in diameter of chin to occiput.
B. Screw to allow gradual tilting of chin.

FIG. 5

Brace applied, postoperative position. A thin layer of gauze may be worn to absorb perspiration.

FIG. 6

Same as Fig. 5 but with chin piece removed.

chin piece and shift of the box shown in Figure 4 just posterior to *A*, to the position marked *A*,— just reversing the present slide arrangement. The cost of the brace is approximately that of the Buckminster Brown brace.

EXTRACAPSULAR FRACTURES OF THE FEMUR IN THE AGED:

A Contribution to the Merits of the Russell Treatment*

BY AUGUST WENDEL, M.D., M.SC. (MED.), CHICAGO, ILLINOIS

Never before or since the introduction of the method advocated by Russell[1] has there been anything simpler or more efficient described for the treatment of fractures of the femur in its upper two thirds, exclusive of the neck. Since too many surgeons are unfamiliar with this fact and as the method can be improved upon so as to minimize pulmonary complications in the aged, the Russell treatment is here reviewed and a means is presented whereby, with the additional use of the Wilkie apparatus, the method is better adapted to extracapsular fractures in this group of persons.

THE RUSSELL APPARATUS

Russell states that the best position in which any fracture may heal is the one most comfortable to the patient. With a broken bone in this position, the part is in physiological rest. In fractures adapted to his method of treatment, the most comfortable position for the patient is flat on the back and with the thigh in abduction and flexion while traction is being applied in its longitudinal axis. The apparatus is so constructed that, after once applied, this position is maintained. It is well, however, to have the resident inspect the outfit at least once daily. The construction is simple and requires only those easily available materials such as a Bradford frame with one overhead centerpiece, four ordinary pulleys, a long piece of window-sash rope, a small five-inch wooden spreader (See Figure 3), a bath towel, and a few safety-pins.

Immediately after the shock of the injury subsides, the foot of the bed is elevated so as to act as countertraction to prevent the patient from slipping downward. By placing one hand under the knee and the other around the ankle, the thigh is gently elevated (flexed), abducted, and inverted — all at the same time — until the distance between both heels is about nine to twelve inches.

Traction is then simultaneously exerted under the knee in the direction of an obtuse angle to the longitudinal axis of the thigh (force *O*, Fig. 1) and through the ankle in the direction of the same axis of the leg (force *N*). The latter two manoeuvers, when combined and their forces properly applied, result in two lines of force *N* and *O* that form the sides of a parallelogram whose diagonal *XY* represents the sum total of the forces (*S*) which exert traction in the longitudinal axis of the femur. While holding the extremity in this position, the apparatus pictured in Figures 2 and 3 is applied.

The overhead center piece on the Balkan frame at its upper end lies directly over the center of the head of the bed and its lower end is directly over the affected or abducted extremity. A bath towel is folded four times end-to-end in the short width, made into a snuggly fitting sling around and under the knee and the top is pinned together with safety pins. One end of the window-sash rope is tied around the top of the sling and the other end is drawn through pulley *A* which is usually located on the center piece over a point one-third of the distance from the knee to the ankle. A Buck's extension made of moleskin is applied to the sides of the leg below the knee and to it is attached a five-inch wooden spreader. Through a small hole in the latter is attached a rope that holds pulley *C*. The end of the sash rope is continued through pulleys *B*, *C*, and *D* to terminate and hold the weight (*W*) several feet above the floor.

Usually eight pounds of weight suffice. Spring scales linked up in an apparatus demonstrate that, with this amount of weight at *W*, the pull in the direction of the longitudinal axis is two times *W*, or sixteen pounds.

*From the Surgical Department of the Northwestern University Medical School.

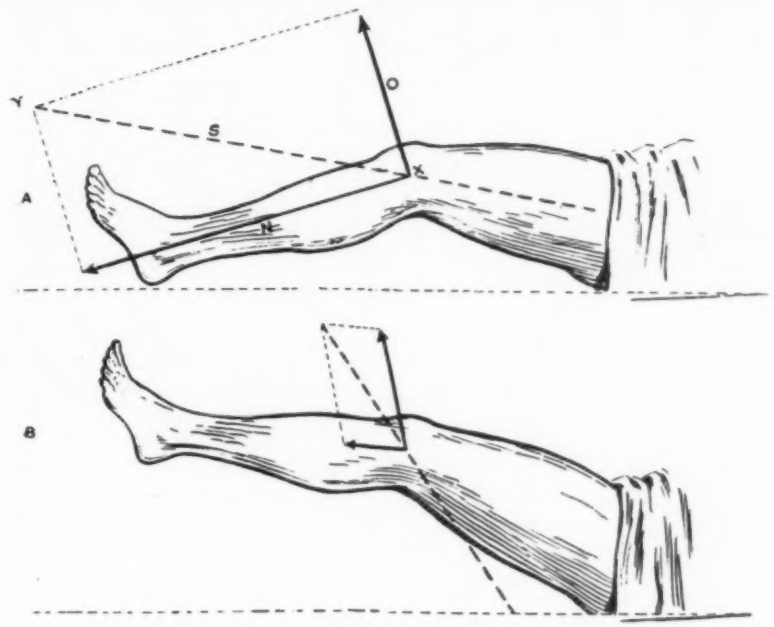


FIG. 1

(*Taken from Russell.*) With the thigh in abduction, flexion, and inversion, the correct and improper manipulation of forces to get the sum total of forces *S* to exert traction in the longitudinal axis of the femur is illustrated.

A. Correct.
B. Improper.

To prevent posterior sagging or gravitation, a pillow is placed under the thigh. At no time need outward angulation be feared. Since elevation of the knee is nature's means of preventing eversion of the extremity, the towel sling by keeping the knee in elevation passively prevents eversion; nevertheless, a sand bag placed against the outer side of the foot further insures inversion.

A single apparatus thus maintains a position of physiological rest for four weeks while it exerts traction in the longitudinal direction of the thigh. This traction can be only approached or equalled by direct skeletal force. The fragments are welded sufficiently by this time to preserve the continuity of the shaft so that any movement of the limb is transferred through the hip joint. After the removal of the apparatus, another week in bed, during which time the patient can sit up but not stand, usually results in consolidation. It is indeed uncommon for complete consolidation to be delayed any longer than five to six weeks.

Briefly stated, the advantages of the method are: (1) a single and self-adjusting apparatus suspends the affected extremity above the surface of the bed in the best position for the fragments to heal, and with the limb raised in this way pressure sores are uncommon; (2) traction is indirectly, but accurately, exerted in the longitudinal axis of the femur and only

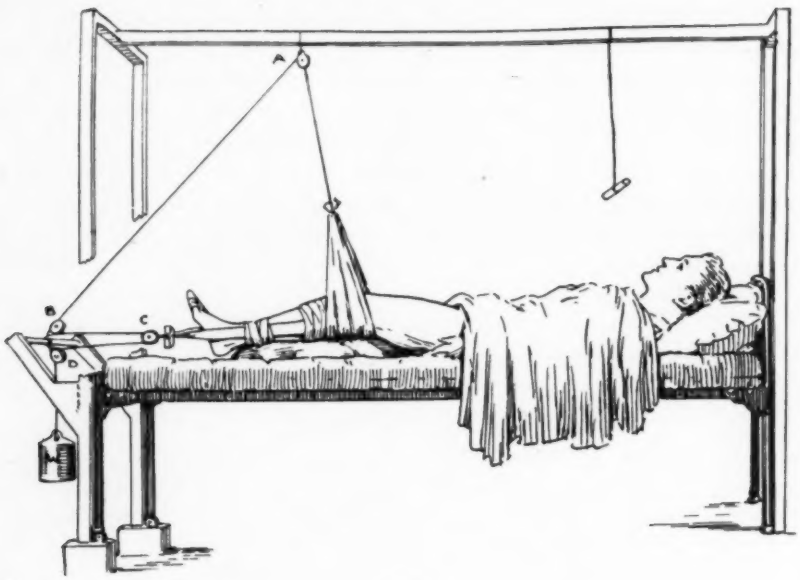


FIG. 2

(*Taken from Russell.*) Russell apparatus.

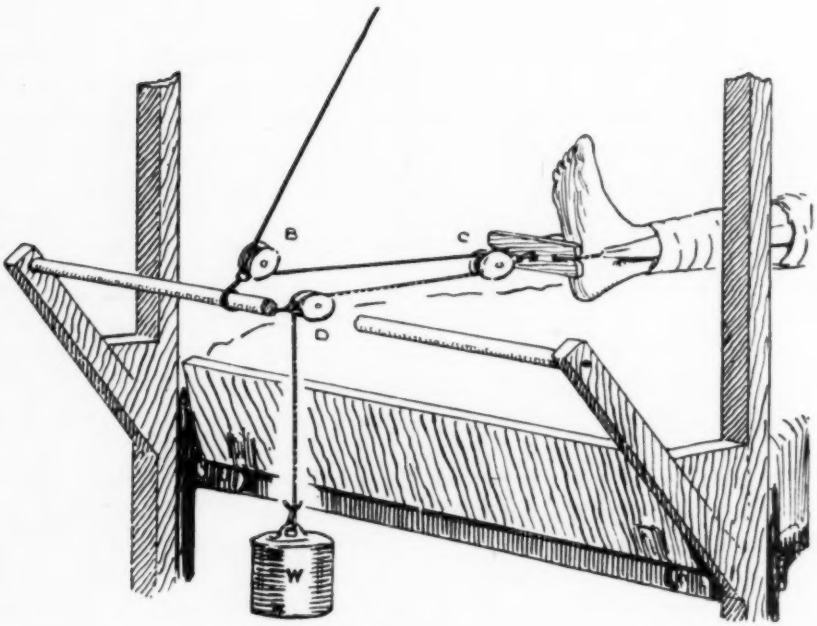


FIG. 3

(*Taken from Russell.*) Arrangement of pulleys, spreader, and weight at foot of bed.

direct skeletal force alone can approach or equal its efficiency; (3) excellent functional as well as anatomical end results are obtained in the majority of cases; (4) the general nursing care is simplified to a minimum; and (5) the back rest can be raised and lowered without interfering with the mechanism of the apparatus and the process of repair.

The length of time the apparatus is to be kept on as advocated by Russell is evidently intended for children and adults up to and including advanced middle life. He mentions nothing about the aged. In such cases it must be left on for six weeks and, since complete consolidation takes around seven weeks, the patient stays in bed during that period. Lying flat on the back for six weeks, in spite of raising and lowering the back rest, is just long enough to proportionately increase pulmonary complications.

There is, however, sufficient fibrous union in the aged within three weeks to prevent any motion of the fragments and to transfer any movement of the extremity through the hip joint so that the apparatus can be removed with safety provided some means is available to immobilize the limb until consolidation is completed.

This is easily accomplished with the apparatus described by Wilkie[2] for the treatment of fractures of the femoral neck. Since Whitman demonstrated that abduction is the essential factor in the treatment of intracapsular fractures and devised the irksome and too often dangerous heavy plaster-of-Paris cast, Wilkie has improvised a more simple plaster-of-Paris apparatus that carries with it a much lower mortality in elderly patients with similar fractures. Without immobilizing the hip joints, it maintains the only two anatomical positions essential to make the fragments heal in good apposition; namely, abduction of both extremities and inversion of the injured member. The sketch shown in Figure 4 demonstrates how it is easier to construct the apparatus in the average hospital by using a wooden cross strip, instead of the brass abduction rod, and two sheet copper collars, to each of which is soldered a hollow cylindrical socket with a thumb screw in its wall to hold the rod after the proper abduction is obtained.

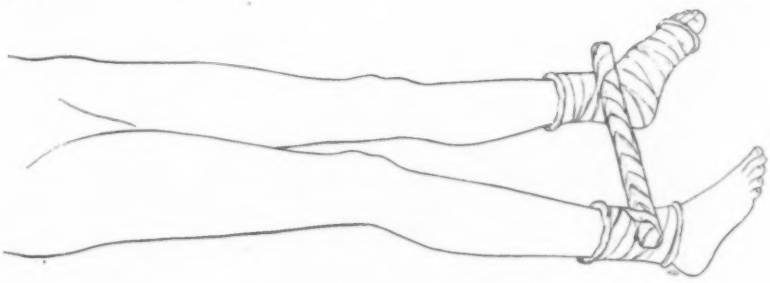


FIG. 4

A Wilkie apparatus as constructed by the author with plaster-of-Paris bandaging and a wooden abduction strip. To demonstrate how the latter is incorporated within the casts, the apparatus is shown only half completed; note also how the bandaging occasionally spirals from side to side across the strip.

After three weeks the Russell apparatus is removed and both lower extremities are gently abducted to a comfortable distance of about twenty inches. The injured limb is then inverted and to it is bandaged to half completion a plaster-of-Paris boot cast from the toes to the junction of the lower and middle thirds of the leg; to the opposite side is next bandaged a half completed four-inch plaster-of-Paris anklet cast. A wooden cross-strip (one by two inches and about twenty-four inches long) is placed anteriorly on the unfinished casts on a level with the malleoli. The procedure this far is sketched in Figure 4. While completing the plaster bandaging and occasionally spiralling it across the wooden strip from side to side, the latter is incorporated within the casts.

After the casts are dry, the patient is gradually shifted to different positions in bed while in the horizontal plane. The raising and lowering of the back rest affords further variation thereto. The earlier removal of the Russell apparatus and the immobilization of the fragments without interfering with movement at the hip joints make it possible to change positions in bed and thus reduce pulmonary complications to a minimum.

Assisted active motion and massage is commenced five weeks after the injury for, as previously mentioned, with the fragments in firm contact movement takes place at the hip joint between the smooth articular surfaces of the acetabulum and head rather than through the fracture.

Seven weeks completes the stay in bed. The casts are removed and the patient sits in a chair for another week, taking care, however, while going to and from the bed, not to bear any weight on the affected limb. For the next six weeks the patient gets around with the aid of crutches and a small lift tacked to the heel and sole of the shoe on the uninjured side. The lifts are then removed and, with the assistance of a cane, partial weight-bearing is permitted for the succeeding four weeks. Hence within five months after the injury, full weight-bearing is again possible. Let it not be forgotten that assisted active motion and massage must be continued until all muscles and joints function as before.

To illustrate what can be accomplished with the combined method, the x-ray pictures of an intertrochanteric fracture in an elderly woman treated this way are shown in Figures 5-A, 5-B and 5-C. The extent of the injury which resulted from a fall directly on the hip is shown in Figure 5-A, taken immediately after arrival in the hospital. Figure 5-B demonstrates the perfect anatomical result after being in the Russell apparatus for two weeks. The patient was allowed to bear full weight on the extremity after four months and Figure 5-C shows the end result one month later, or five months after the injury. There was no material shortening of the limb, no limp, and no postural compensatory changes.

SUMMARY

The Russell treatment is the simplest and most efficient heretofore described method for fractures of the femur in its upper two thirds outside

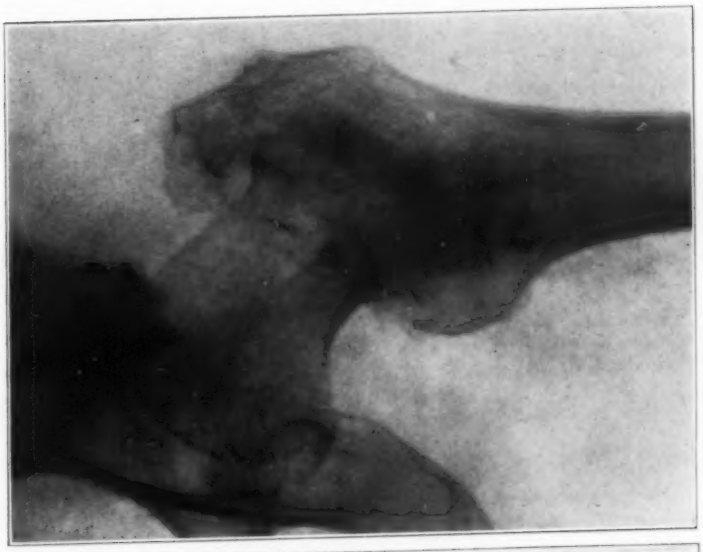


FIG. 5-C

FIG. 5-B

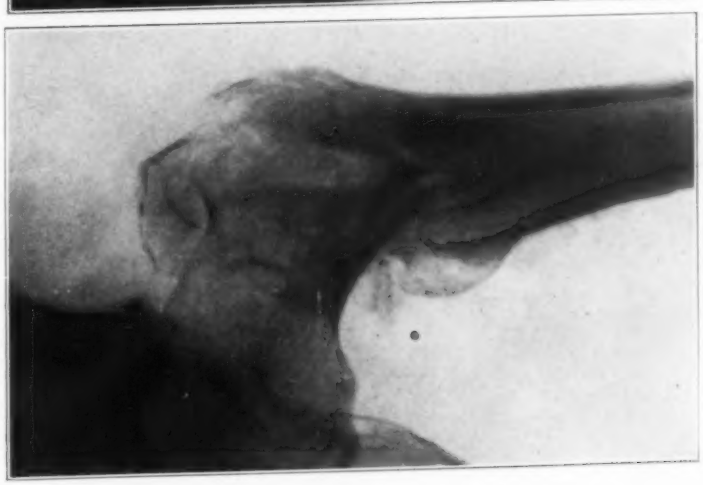


FIG. 5-A

of the joint capsule. If the surgeons who are unfamiliar with the method were aware of the accurate traction that the Russell apparatus exerts in the longitudinal axis of the femur, and were to give it due trial, its popularity would greatly increase and direct skeletal force would not be so popular in the treatment of similar fractures in this region.

The introduction of the Wilkie apparatus into the Russell treatment better adapts the latter to extracapsular fractures in the aged, as pulmonary complications are reduced to a minimum. This reduction of complications is due to two reasons: (1) it is no longer necessary to lie flat on the back for six weeks; (2) after three weeks and until six weeks after the injury, while in the Wilkie apparatus, the patient may be shifted in bed to any position in the horizontal plane. After the seventh week consolidation is usually completed in aged patients and the Wilkie apparatus is removed.

REFERENCES

1. Russell, R. H.: Fracture of the Femur: A Clinical Study. British J. Surg., XI, 491, 1924.
2. Wilkie, D. P. D.: The Treatment of Fracture of the Neck of the Femur. Surg. Gynec. Obstet., XLIV, 529, 1927.

WILLIAM STEVENSON BAER

WILLIAM STEVENSON BAER

Dr. William Stevenson Baer died suddenly at the height of his active career on April 7, 1931, in Baltimore. Born November 25, 1872, the son of Robert Newton and Mary Corner Baer, he received his preliminary education at public schools and the Baltimore City College. He received his A.B. degree from Johns Hopkins University in 1894, and four years later his M.D. He served as House Officer at the Johns Hopkins Hospital for two years in Surgery, and was appointed Assistant in Surgery with charge of the newly established orthopaedic clinic in 1900. He had charge of this clinic from its inception through its development into a special Department of Surgery, and became

the first Clinical Professor of Orthopaedic Surgery of the Johns Hopkins University in 1927. In 1901, he married Ruth Adams, who survives him, as do two brothers.

Dr. Baer was a member of the Johns Hopkins Hospital Unit (Base No. 18) which went to France in June 1917, but was soon drafted from this to Headquarters at Chaumont where he was Orthopaedic Consultant. His duties carried him to all divisions of the American Expeditionary Forces in France and he only returned to be discharged in this country in January 1919.

His colleagues bestowed upon him in 1924 the Presidency of the American Orthopaedic Association in recognition of his service to and position in the field of orthopaedic surgery.

Dr. Baer's most outstanding and tangible monument is the Children's Hospital School in Baltimore, for he was the creative and guiding genius of this now large, active, and splendid institution for the care of crippled children. Begun only in 1912, it is now one of the best known and influential hospitals of its kind, and the work done there has served as a stimulus to the better care of crippled children elsewhere.

Dr. Baer's most lasting and subtle contribution, however, lay in three other fields:

First, as a teacher, who occupied the front rank of those whose students turned from the old, narrow conception of orthopaedics to the newer, more modern one of surgery of the bones and joints, and brought to its problems some of their masters' curiosity and enthusiasm along with a mind trained in the fundamentals.

Second, as a critic, who exploded rash or unsound suggestions with fearless disregard of consequences, and kept the specialty from many a false turn and blind alley of thought.

Lastly, as an investigator, who brought to research an insatiable curiosity, a vital enthusiasm and energy, a high courage, and a vivid imagination, which are the essential qualities of an explorer for science.

As a leader of our profession in a critical time of expansion and as an inspiring personality, Dr. Baer will be sadly missed, but he had the great privilege of dying while life and interest in all his work still burned high and bright; so his passing was like a great tree crashing in a storm and not succumbing to age and decay.

Dr. Baer's associates in the American Orthopaedic Association passed the following resolution at their Annual Meeting:

William Stevenson Baer will no more be seen amongst us. To the world, he has represented all that was fine and admirable in a physician. In the medical profession, his name has, for years, been associated with all of the enviable prominence which comes to the skillful, resourceful surgeon; the bold innovator whose promises have come true; the painstaking teacher whose lessons have been carried to the ends of the earth. To us, his colleagues of the American Orthopaedic Association, he has been all of these things, but much more. He has been the faithful friend, the cheerful companion, and the loyal champion in behalf of scientific advance and accomplishment in the field to which we are devoted. Much too soon has he departed from us. We sorrowfully record this hour when his continuing absence from this gathering begins. We devote our affectionate and appreciative thought to his delightful personality, which we shall never forget.

Be it resolved that this memorial be spread upon the minutes of the meeting of the American Orthopaedic Association, assembled in Memphis, Tennessee, April 18, 1931, and that it be transmitted to Mrs. Baer together with our expression of profound sympathy.

News Notes

The editorial office of *The Journal* is being moved this month to the Medical Library Building, 8 The Fenway, Boston, which will be the address of *The Journal* in the future. The telephone number is Kenmore 3420.

The Forty-fifth Annual Meeting of the American Orthopaedic Association was held in Memphis, April 15 to 18, presided over by the President, Dr. Willis C. Campbell.

An unusually large number of members and guests were present and took part in the scientific and social activities provided by the Program Committee and by the President and his Entertainment Committee.

The first day was devoted to clinical demonstrations and presentations of cases by Dr. Campbell and his associates, as follows:

Pseudomycosis ..... Dr. J. F. Hamilton
Sacro-iliac and Lumbosacral Fusion ..... Dr. Joseph I. Mitchell
Arthroplasties ..... Dr. Willis C. Campbell
Drop-foot ..... Dr. J. S. Speed
Bone Grafts for Fractures of the Neck of the Femur
Drs. Campbell, Speed and Mitchell
Rare Cases and Tumors ..... Staff

The two following days were devoted to the presentation of papers by members and invited guests as follows:

APRIL 16

Symposium on Backache:
Anatomical Considerations.
Dr. Theodore A. Willis, Cleveland, Ohio (by invitation).
Orthopaedic Aspect.
Dr. Lloyd T. Brown, Boston, Mass.
Surgical Aspect.
Dr. Edwin W. Ryerson, Chicago, Ill.
Gynecological Aspect.
Dr. Fred L. Adair, Minneapolis, Minn. (by invitation).
Neurological Aspect.
Dr. Walter E. Dancy, Baltimore, Md. (by invitation).
Urological Aspect.
Dr. George R. Livermore, Memphis, Tenn. (by invitation).
Industrial Aspect.
Dr. P. B. Magnuson, Chicago, Ill. (by invitation).
Discussion by Dr. E. G. Brackett, Boston, Mass.
Dr. Frank D. Dickson, Kansas City, Mo.
Dr. Eustace Semmes, Memphis, Tenn.
Dr. W. W. Plummer, Buffalo, N. Y.
Dr. James A. O'Reilly, St. Louis, Mo.
Open Reduction of Congenital Dislocation of the Hip.
Dr. Frederick C. Kidner, Detroit, Mich.

A New Departure in the Treatment of Congenital Dislocation of the Hip.
Dr. Arthur Krida, New York, N. Y. (by invitation).
Discussion by Dr. Z. B. Adams, Boston, Mass.
Dr. Frederick J. Gaenslen, Milwaukee, Wis.
Dr. Frank Ober, Boston, Mass.
Dr. Samuel Kleinberg, New York, N. Y.
Cystic Disease of a Vertebra with its Relationship to the Arterial Supply.
Dr. DeForest P. Willard, Philadelphia, Penna. and
Dr. George Wagoner, Philadelphia, Penna. (by invitation).

APRIL 17

The President's Address.
Dr. Willis C. Campbell, Memphis, Tenn.
Certain Desmogenous Tumors in Their Orthopaedic Aspect.
Dr. Albert H. Freiberg, Cincinnati, Ohio.
Discussion by Dr. Arthur Steindler, Iowa City, Iowa.
Fractures of the Cervical Spine.
Dr. James O. Wallace, Pittsburgh, Penna.
Discussion by Dr. Eustace Semmes, Memphis, Tenn.
A New Approach to the Radical Surgical Treatment of Osteomyelitis of the Os Calcis.
Dr. Frederick J. Gaenslen, Milwaukee, Wis.
Discussion by Dr. Emil S. Geist, Minneapolis, Minn.
Liver Meal in the Treatment of Amyloidosis in Surgical Tuberculosis—a Preliminary Report.
Dr. Brainerd H. Whitbeck, New York, N. Y.
Discussion by Dr. Z. B. Adams, Boston, Mass.
Dr. Armitage Whitman, New York, N. Y.
Dr. Charles Sevier, Denver, Col.
An Operation for the Correction of Extremely Relaxed Flat Feet.
Dr. Michael Hoke, Atlanta, Ga.
Discussion by Dr. Leo Mayer, New York, N. Y.
Dr. Oscar L. Miller, Charlotte, N. C.
Pathological Mechanics of Hand and Finger Contractures.
Dr. Arthur Steindler, Iowa City, Iowa.
Contractures of the Hand Resulting from Infections and Injuries.
Dr. Sterling Bunnell, San Francisco, Calif. (by invitation).
Discussion by Dr. Robert V. Funsten, Detroit, Mich.
Dr. Leo Mayer, New York, N. Y.

APRIL 18

Experimental Study of the Distribution of the Peripheral Blood Flow.
Dr. Barney Brooks, Nashville, Tenn.
Discussion by Dr. John A. Key, St. Louis, Mo.
Arthritis—Indications for and Results of Sympathetic Ganglionectomy and Trunk Resection.
Dr. M. S. Henderson, Rochester, Minn. and
Dr. A. W. Adson, Rochester, Minn. (by invitation).
Discussion by Dr. D. E. Robertson, Toronto, Canada.
Treatment of Vascular Diseases of the Extremities by Sympathectomy.
Dr. D. E. Robertson, Toronto, Canada.
Discussion by Dr. William B. Carrell, Dallas, Texas.
The Résumé of Recent Operative Procedure in Congenital Elevation of the Scapula.
Dr. Robert D. Schrock, Omaha, Nebr.
Discussion by Dr. Frank D. Dickson, Kansas City, Mo.

The Use of the Anterior Superior Spine in Hip Surgery: 1. Arthrodesis; 2. Shelf Operation for Congenital Dislocation.

Dr. Ralph K. Ghormley, Rochester, Minn.

Discussion by Dr. H. Wallace Cole, St. Paul, Minn.

The Association has recently lost one of its most prominent and valuable members, Dr. William S. Baer, who died April 7. The Committee on Resolutions, Dr. Albert H. Freiberg, Chairman, presented a Memorial which was adopted by the Meeting. (See page 624.)

The Membership Committee announced the following:

Elected to Active Membership:

Carl E. Badgley, M.D., Detroit, Mich.
F. T. A. Chandler, M.D., Chicago, Ill.
C. C. Chatterton, M.D., St. Paul, Minn.
R. B. Deane, M.D., Calgary, Canada.
C. W. Peabody, M.D., Detroit, Mich.
Winthrop Phelps, M.D., New Haven, Conn.
F. N. Potts, M.D., Buffalo, N. Y.
A. R. Shands, Jr., M.D., Durham, N. C.
Elmer P. Weigel, M.D., Plainfield, N. J.
T. A. Willis, M.D., Cleveland, Ohio
H. J. Wyckoff, M.D., Seattle, Wash.

Elected Honorary Members:

Elliott G. Brackett, M.D., Boston, Mass.
Royal Whitman, M.D., New York, N. Y.

Elected Corresponding Member:

Prof. Henry Turner, Leningrad, Russia.

Elected Emeritus Member:

Charles F. Painter, M.D., Boston, Mass.

The following officers were elected for the ensuing year:

President: William E. Gallie, M.D., Toronto, Canada.
President-Elect: Arthur Steindler, M.D., Iowa City, Iowa.
Vice-President: F. J. Gaenslen, M.D., Milwaukee, Wis.
Treasurer: John L. Porter, M.D., Evanston, Ill.
Secretary: DeForest P. Willard, M.D., Philadelphia, Pa.
Executive Committee: Willis C. Campbell, M.D., Memphis, Tenn.
Membership Committee: Roland Hammond, M.D., Providence, R. I.
Program Committee: David E. Robertson, M.D., Toronto, Canada.

Delegates to American College of Surgeons: Dr. John L. Porter, Dr. J. P. Lord and Dr. H. Winnett Orr.

Delegate to Congress of American Physicians and Surgeons: Dr. George E. Bennett in the place of Dr. William S. Baer deceased.

Alternate Delegate to Congress of American Physicians and Surgeons: Dr. J. Torrance Rugh, Philadelphia, Penna.

An invitation was received from the Czecho-Slovakian Orthopaedic Society for a member of the American Orthopaedic Association to attend the Annual Meeting to be held at Brno in September. Dr. E. G. Brackett was appointed the official delegate.

The next Meeting will be held in Toronto, June, 1932.

The Journal records with regret the deaths of five members of the **British Orthopaedic Association:**

C. B. Alexander, Liverpool.
J. B. Barnett, Stanmore.
A. Blackstock, Wolverhampton.
S. Alwyn Smith, Cardiff, Wales.
W. C. Stevenson, Dublin, Ireland.

Dr. David Sashin announces the removal of his office to 51 West 86th Street, New York, N. Y.

Dr. O. L. Miller and Dr. William M. Roberts announce the removal of their offices to the Medical Arts Building, Charlotte, N. C.

Dr. C. F. Eikenbary and Dr. John F. LeCocq announce the association of Dr. Edward LeCocq with the Seattle Orthopaedic and Fracture Clinic, 1011 Summit Avenue, Seattle, Washington.

The Twenty-sixth Congress of the Deutsche Orthopädische Gesellschaft will be held in the Langenbeck-Virchow-Haus in Berlin on September 14–16 under the leadership of Prof. G. A. Wollenberg, President. The principal topics for discussion are: (1) Heredity and Orthopaedic Surgery, Readers: Dr. v. Verschuer, Berlin, and Prof. Valentin, Hannover; (2) Spastic Paralyses, Readers: Dr. Hoffmann, Freiburg and Dr. Stoffel, Mannheim; (3) Operative Treatment of Flat-Foot, Reader: Dr. Schrader, Heidelberg.

At the Executive Committee Meeting of the **British Orthopaedic Association** held on April 22, the following were elected Associate Members:

A. C. Armstrong, Epping, Sydney, Australia.
L. W. Norman Gibson, The Open Air Hospital for Children, Leasowe, Cheshire.
H. J. Seddon, The Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Middlesex.
Maurice Sinclair, 122, Harley Street, London, W. 1.
V. J. Morcom Taylor, 6, Sefton Park Road, Liverpool.

The following Honorary Members were also elected:

Prof. H. von Baeyer, Schierbach Orthopädische Klinik, Heidelberg.
Prof. H. Gocht, Genthinerstrasse 16, Berlin, W. 35.
Prof. Fritz Lange, Mozartstrasse 21, Munich.
Prof. H. Spitzy, Frankgasse 1, Vienna.

The Spring Meeting of the **British Orthopaedic Association** was held in Aberdeen on Friday and Saturday, June 12 and 13, 1931. The session on Friday morning was at the Anatomy Department, Marischal College and was devoted to a discussion on "Congenital Club Foot (Congenital Talipes Equinovarus)" which was opened by Mr. E. P. Brockman. At noon a paper was presented by Prof. Waldenström of Stockholm on "Three Different Kinds of Deformations in the Hip After Epiphyseolysis Capitis Femoris". The afternoon was spent in a visit to the Children's Hospital where interesting cases were shown by members of the staff. The session on Saturday morning was held in the Surgery Department, Marischal College, and included demonstration of water colors of nerve lesions, etc., and of museum specimens by Sir John Marnoch and a demonstration of a modified Thomas's splint and method of extension of fractured femur by Mr. J. Taylor of Dundee. A visit to the Rowett Research Institute followed where a demonstration was given by Dr. H. Winnett Orr of Lincoln, Nebraska.

The Seventh Congress of the Czecho-Slovakian Orthopaedic Society will be held in Brno, September 27 and 28. An interesting program is being arranged by the Committee under the direction of Dr. Bedřich Frejka, President. The principal subject of the meeting will be The Mineral Metabolism and its Relation to the Skeleton. Among the speakers are: Dr. Laufberger, Dr. Bečka, Dr. Zimák and Dr. Frejka.

Current Literature

BACKACHE. By James Mennell, M.A., M.D., B.C. Philadelphia, P. Blakiston's Son & Co., 1931. $3.00.

Dr. Mennell has presented a monograph on the subject of "Backache", confining himself to this one subject with a thoroughness and completeness that is seldom found. His wide experience in all phases of this subject, dating back to the World War, enables him to speak with authority.

A résumé of the development of the interest which has been taken in this subject is given, followed by a consideration of the methods and means of diagnosis and treatment. He insists upon a thorough routine of examination, taking up each factor which could in any way influence the diagnosis, prognosis, and determination of treatment. Considerable importance is given to slight degrees of asymmetry of the bony contour; this sometimes seems to be overemphasized, for the normal range of symmetry allows considerable variation. If sometimes he has been a little too definite in conclusions drawn from isolated signs and symptoms, or has given undue importance to the influence of some of the anatomical or pathological conditions, he can easily be forgiven, for he has merely erred on the side of thoroughness. If some of the tests are considered a little too pathognomonic, there should be no criticism, for a long experience in a somewhat limited field allows one to enter with temerity and certainty where a larger experience in a wider field would cause one to hesitate or to treat with less surety. The various affections found in the low back are considered in detail, giving the symptoms with their significance. Of particular value is the discussion of the various regions (sacro-iliac, lumbosacral and lumbar) and the affections found there. The anatomical variations, strains, and pathological conditions are considered. The chapter on the use and principles of the application of mechanical support is also valuable. Dr. Mennell is evidently much interested in the manipulative forms of treatment and has given descriptions, illustrated by line drawings, of the various manipulations which may be used in the large number of affections of the spine which require this treatment, with directions as to when they may be employed.

This book is valuable not only for the general practitioner but also for the orthopaedic surgeon of experience; in fact, all will find a fund of helpful information in the various personal experiences recorded by the author.

DIE MUSKELHÄRTEN, IHRE ENTSTEHUNG UND HEILUNG (Myogeloses, Their Development and Treatment). By Privatdozent Dr. Max Lange, Oberarzt der Orthopädischen Klinik München. Munich, J. F. Lehmanns, 1931.

Under this title, which by derivation means "freezing of the muscles", Max Lange has written a monograph dealing with sharply localized areas of hardening in the muscles. Though specialists in massage have for many years insisted they could feel "knots" or lumps in painful muscles, little credence has been given to their assertion by the medical profession. Not until 1921 when Fritz Lange and Schade published independent reports of their observations has the condition been given due recognition. The subject is of great practical importance since the myogeloses are frequently the chief cause of pain, erroneously supposed to be due to neuritis, bursitis, arthritis, etc.

To palpate these areas of hardening, the muscle must be relaxed by the appropriate posture, the skin should be oiled with liquid paraffin and the physician must use the greatest gentleness. The masses vary in length from one-quarter to three or four centimeters. They are usually elongated in shape, running in the direction of the muscle fibers, and are found most characteristically near the origin or insertion of the muscle.

To study the myogeloses objectively, Lange used a simple pressure gauge (sclerometer), devised by Mangold, to measure accurately the resistance they offered, and for

microscopic examination a number were excised. No pathological changes whatever were found by Prof. Borst, head of the pathological department of the University of Munich, thus differentiating the myogeloses sharply from true myositis and the so called *muskelschwielen* or muscle scars. The change in the consistency of the muscles is probably caused by an interference with the normal chemical processes, resulting in an increase in the lactic acid of the muscle.

Appreciable hardening of a muscle was produced experimentally in rabbits by tetanizing a muscle for forty-five minutes and also by fastening an ice-bag to the rabbit's leg for ten hours. At the suggestion of Prof. Abderhalden an attempt was made to restore these muscles to normal consistency by injecting salts to neutralize the excess lactic acid. Sodium carbonate and bicarbonate, sodium phosphate and pyrophosphate were tried. Of these, the two latter produced a disappearance of the abnormal hardening within twenty minutes.

The myogeloses may be divided etiologically into four groups:—those caused by (a) exposure to cold, (b) infections, (c) overexertion, (d) abnormal metabolism. The treatment consists: first, in the removal of the cause, if this be toxic or metabolic; second, in the daily massage of the myogeloses. A peculiar method of massage has been evolved known as *gelotripsy*. This consists of a powerful stroking motion either of the fingers or of the knuckles, designed to break up the nodular thickenings. For deep-seated myogeloses, rounded pieces of wood, shaped like a sprouting mushroom, can be used to good effect. The *gelotripsy* should be followed by a gentle massage directed toward the muscle belly. Despite the painful character of the treatment, Lange has only in exceptional instances found it necessary to anaesthetize the muscles with novocain. Sensitive patients are given a sedative one-half hour before the massage. The treatment of a single muscle requires fifteen to twenty minutes; consequently, when many muscles are involved, not all can be treated daily, since this would be too much of a strain for the patient. When possible, however, daily treatments should be given till the myogeloses have disappeared. Following a *gelotripsy*, the skin and subcutaneous tissues show extensive ecchymoses, so characteristic as to be diagnostic of the disease.

The first half of the monograph deals with the general description of the myogeloses, the second with the occurrence under special conditions. Their prevalance is indicated by the chapter headings of this second part:—

Myogeloses associated with rheumatic diseases, rheumatic headache, wry-neck, lumbago, chronic muscular rheumatism, sciatica and pseudosciatica, occupational neuroses, accidents and injuries incidental to daily life, pain due to horseback riding, gymnasium exercise and mountain climbing, industrial accidents, humeroscapular periarthritis (subacromial bursitis).

Myogeloses due to static imbalance:

(1) of the leg,—flat-foot, knee pain, hips stiffened in improper position.
(2) of the trunk,—scoliosis, kyphosis, increased lumbar lordosis and low back pain, healed tuberculous spondylitis, old vertebral fractures.

Myogeloses associated with chronic pathological joint changes:

(a) arthritis deformans of the hip,
(b) arthritis deformans of the spine,
(c) untreated congenital dislocations of the hip and reduced hips showing anatomical changes,
(d) coxa vara, coxa valga, and Calvé-Legg-Perthes' disease,
(e) of a sound leg due to disease of the other leg.

Metabolic diseases and disturbances of the internal glandular secretions.

The monograph is written in a lucid, convincing style; the illustrations help the reader to grasp the details of this new subject; the case histories are well selected to bring out interesting features in the diagnosis and treatment.

The monograph constitutes another noteworthy contribution from a clinic which we in America have grown to look upon as one of the leaders in German orthopaedic thought and practice.

TRAUMATOTHERAPY. By John J. Moorhead, B.Sc., M.D., F.A.C.S. Philadelphia, W. B. Saunders Company. $7.00.

Dr. Moorhead has developed an excellent textbook on surgery of trauma. It is a practical treatise and will serve as a useful guide for all surgeons confronted with injury cases, a group that is increasing so rapidly that accident surgery, as the author terms it, is becoming a specialty.

The author's simple and common-sense methods, so concisely stated, arouse the admiration of any one familiar with this type of surgery. He has discarded many cumbersome operations and replaced them by rest, heat, massage, and when necessary rather simple operative procedures. The outstanding feature in many conditions is the emphasis placed upon the restoration of function in the disabled part.

The only criticism that can be offered is in the terseness or brevity of his remarks in certain conditions. One wishes that he would be more explicit in certain traumas in pointing out that, whereas descriptions of operative procedures are mentioned, yet in the majority of cases of this given trauma operation is unnecessary. This is especially true in some of his fracture operations and in skull fractures.

One familiar with Dr. Moorhead's work realizes that he has given to the profession the best and most practical methods gathered from many years of vast experience. This book, combined with his other book on Traumatic Surgery will prove invaluable to any surgeon dealing with traumatic cases.

CHIRURGIE MAXILLO-FACIALE. By Gerard Maurel. Paris, Norbert Maloine, 1931. 120 francs.

This volume is largely based on a series of lectures in which the author takes up the large number of affections which are found in the facial and maxillary area. Since it is compiled from these lectures, the book contains more detail than is ordinarily found in a work of its kind. In considering this subject, however, this is a great advantage for, except for a small number of specialists, few have paid particular attention to this phase of surgery. Methods of the preparation of instruments to be used in operation are given, with directions for the aseptic technique to be employed in this particular anatomical area. Practically all the different local surgical problems are taken up, as well as the diagnosis and treatment of the various affections, with descriptions of the operative procedures. Many of the conditions described are not of especial interest to either the orthopaedic or the general surgeon, but the consideration of some of the conditions of the teeth, which so largely influence joint conditions, is of distinct value to both surgeons. This is especially true in the discussion of the treatment of fractures of the jaw. The author has included a chapter on the harelip and cleft-palate in which he has grouped the different types and given detailed descriptions of the operative treatment. In addition to these special chapters, there is much material of value to the dental surgeon.

This volume contains 867 pages, is profusely and well illustrated, and should be among the books of surgeons interested in various specialties.

A TEXTBOOK OF SURGERY. By John Homans, M.D. Springfield, Illinois, Charles C. Thomas, 1931. $9.00.

For the purposes of the general surgeon the consideration given in this volume to those subjects which constitute the major part of an orthopaedic surgeon's field of activity is adequate and very little criticism could be made of the way the matter has been handled. For those of our surgical confrères, who feel that the surgical field has been invaded by the orthopaedic surgeon, considerable backing for this view might be put forward, in as much as fourteen chapters, or twenty-five per cent. of the total number in the volume, are largely devoted to orthopaedic subjects. To those who believe, as does the reviewer, that the teaching of orthopaedic surgery should be under the headship of the departments of surgery in our Schools, by an orthopaedic surgeon, who may be designated as an Assistant Professor of Surgery (Orthopaedic), if you will, this book takes

a stand which is quite the proper one to maintain. One of the noteworthy features of the volume is the fact that it is compiled by one author and though the advice of others was sought, and is acknowledged, still the unity of authorship is far better preserved than in the many Systems of Surgery which during the past twenty-five years have been offered to the profession. The orthopaedic subjects have fared alike with other matter in the book and the author should be commended for having produced a well balanced treatise. It is to be hoped that in the future, as need for new surgeries shall be met, their authors will see the wisdom of following Dr. Homans' example.

DIE TECHNIK DES UNGEPOLSTERTEN GIPSVERBANDES. By Dr. Fritz Schnek. Vienna, Wilhelm Maudrich.

Under the above mentioned title, Dr. Fritz Schnek of Vienna who is first assistant in the Böhler Clinic, gives a complete review of the methods of applying plaster-of-Paris, as used in the Böhler Clinic.

The book is well gotten up and nicely illustrated. It can well be considered a companion piece to Böhler's small volume on the technique of the treatment of fractures which has already appeared in the second edition in German. Schnek contrasts the advantages of the unpadded cast with the disadvantages of the padded plaster-of-Paris cast and splint. For those who are employing the Böhler methods in the treatment of fresh fractures, this volume will be of great interest.

CRIPPLED CHILDREN, THEIR TREATMENT AND ORTHOPEDIC NURSING. By Earl D. McBRIDE, M.D. St. Louis, C. V. Mosby Company, 1931. $3.50.

Because of the widespread interest in the welfare of crippled children, whose care during long periods of convalescence of necessity cannot be limited to hospital clinics, Dr. McBride's book will prove of practical value. When medical students, nurses, and social workers have acquired the knowledge which the book contains, they are bound to appreciate better and cooperate more fully with the efforts of the orthopaedic surgeons. The author has accomplished his object by simple, clear descriptions of orthopaedic conditions for the benefit of those without medical training who are interested in the crippled child, and by definite explanatory instructions to the orthopaedic nurse.

An unpretentious volume of 280 pages, including 159 beautiful illustrations and a well arranged index with tabulated definitions of orthopaedic terms, it may well appeal to the student.

It is to be regretted that there exists no volume just as valuable for the guidance of those who are struggling with another equally important factor in the care of crippled children, — their educational needs and training at an age when loss of much time from school is a serious handicap and ordinary school attendance is impossible.

AMERICAN PHYSICIANS AND SURGEONS. Prepared by James Clark Fifield. Minneapolis, The Midwest Company, 1931. $30.00.

This large work will be found most valuable as an aid to determining the professional position of principal members of the medical profession in the United States and Canada. The list comprises medical men prominent in their profession with the necessary data to designate their professional standing. It is necessary that names of some of the prominent men are not included in a book of this scope, for it would not be possible that all be gathered, but the author has evidently selected the representation with a great deal of care, and confidence can be put in the standard of those whose names appear. It is of great advantage to have reliable information as to the position, education, training, and experience of those medical men, in regard to whom it may be necessary or desirable to have knowledge as to their professional position and standing. This is especially true of

the medical profession, and this book supplies the necessary data. In addition to the information in regard to members of the profession there is given a list of the principal hospitals, with their rating and their relation to the American College of Surgeons, the American Hospital Association, and the American Medical Association. There is also given a list of the various health resorts, with their standing, all of which should be of exceptional aid to those who are inquiring, and who need information on this subject. This book is a large volume of 1737 pages attractively presented.

PRACTICAL ANAESTHETICS FOR THE STUDENT AND GENERAL PRACTITIONER. By Charles F. Hadfield. Ed. 2. New York, William Wood & Co., 1931. $3.50.

A very practical book for the student or general practitioner who wishes to learn to give anaesthetics with understanding but does not expect to become a specialist. Especially to be commended are Chapter 2 on general considerations in the giving of anaesthetics, and Chapter 4 on maintaining the airway. The newer anaesthetics such as ethylene, spinocain and avertin are taken up, but most of the book is devoted to the ordinary anaesthetics and the care of the patient.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Norsk Magasin for Laegevidenskapen. Oslo, Vol. XCII, Nos. 4, 5, April and May, 1931.

Akutt Appendicit og Akutt Salpingit. By Arne J. A. Arnesen. Tilleggshefte til Norsk Magasin for Laegevidenskapen. Oslo, Vol. XCII, No. 4, April, 1931.

Ein Operierter Fall von Tendinitis Calcificans Trochanterica. By Harald Nilsonne. Acta Orthopaedica Scandinavica, I, 231, 1930.

Hallux Rigidus and Its Treatment. By Harald Nilsonne. Acta Orthopaedica Scandinavica, I, 295, 1930.

Ortopedia e Traumatologia dell' Apparato Motore. Rome, Vol. III, No. 1, February, 1931.

Chronic Arthritis; Its Relationship to Allergy and Skin Sensitization. By Ernest R. Eaton. The Journal of the American Institute of Homeopathy, February, 1931.

Der Bauch als Hilfstragorgan der Wirbelsäule. By A. Schanz. Archiv für Orthopädische und Unfall-Chirurgie., Vol. XXIX, 245, 1931.

Slovanský Sborník Ortopedický. Brno, Czecho-Slovakia, Vol. VI, Nos. 1 and 2, 1931. Le Monde Medical. Paris, Vol. XLI, No. 782, January 1, 1931.

Bullettino e Atti della Reale Accademia Medica di Roma. Rome, Vol. LVII, No. 4, April, 1931.

Le Officine Ortopediche of Pio Istituto dei Rachitici Clinica Ortopedica della R. Università di Milano. By Prof. R. Galeazzi. Milan, 1931.

Revista de Cirugia de Barcelona. Barcelona, Vol. I, No. 1, January, 1931.

In Welchem Umfange Werden Orthopädische Apparate in der Krüppelfürsorge Tatsächlich Getragen? By Prof. Dr. Hohmann. Zeitschrift für Krüppelfürsorge. Vol. XXIII, 260, 1930.

Bulletin of the National Tuberculosis Association. New York, Vol. XVII, Nos. 4, 5, 6, April, May and June, 1931.

*Clinical Observations on the Surgical Pathology of Bone. By David M. Greig, M.B., C.M., F.R.C.S. Edin., F.R.S.E., Edinburgh, Oliver & Boyd Ltd., 1931.

*Practical X-Ray Treatment. By Arthur W. Erskine, M.D , St. Paul, Bruce Publishing Company, 1931.

*To be reviewed in a later issue of *The Journal*.

A Case of Echinococcus Cysticus Intraspinalis. C. C. Fleischer-Hansen. *Acta Chir. Scandinavica*, LXVI, 293, 1930.

The case reported occurred in a female, age forty-nine, the daughter of a butcher. No domestic animals were kept at home. At the age of forty-eight she incurred violent neuralgic pains and tingling paraesthesias in the fibular dorsal region of the right foot. These pains extended gradually upward on the posterior and external aspect of the extremity. Weakness of the limb appeared. In six months the left extremity was involved also to such an extent as to confine the patient to bed.

Examination revealed a distinct supranuclear paresis of both legs; no perineal anaesthesia. Sensibility for pricking was slightly reduced and showed a segmentary limitation corresponding to the eighth cutaneous segment. Lumbar puncture was negative. Intraspinal lipoidol injection revealed a block at the eighth dorsal vertebra, convex in shape. No bony destruction of the spine was present in the x-ray. The remainder of the examination was negative.

At laminectomy, the sixth, seventh, and eighth neural arches were removed. Lying to the left and somewhat anteriorly was a plum-sized tumor, extradural in location. On attempting to remove it, rupture occurred, revealing about twenty smaller cysts. On tracing these a cavity, located posteriorly and on the left side within the body of the seventh dorsal vertebra, was found. Curettage was performed. The floor of this cavity seemed healthy. The dura was opened; no pathology was found. After operation patient went into shock, was treated, and was normal the next day. Continuous improvement was occurring three months after operation.

Histological examination revealed a thickened layer within which was a very thin germinal layer in which incipient formations of daughter cysts were visible. The cavity of the mother cyst was filled with daughter cysts.

The author does not believe the cyst arose from bone, because the base of the cavity seemed healthy and because echinococcus tumors of the vertebral column spread throughout the spongiosa of a vertebral body rather than forming a large cystic tumor.

The disease is rare in Denmark. The previous Danish cases are recorded. Laminectomy for intraspinal echinococcus cysts has been performed previously on twenty-two patients, sixteen (72.8 per cent.) of whom died.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Über Behandlung der Knochen—Gelenk—Tuberkulose mit Aurum Kalium Cyanatum (The Treatment of Bone and Joint Tuberculosis With Aurum Potassium Cyanate). M. Friedland. *Acta Chir. Scandinavica*, LXVIII, 82, 1931.

After the extremity has been partially exsanguinated by an Esmarch bandage, three-tenths to two cubic centimeters of a one per cent. solution of aurum potassium cyanate are injected with novocain into a focus of bone or joint tuberculosis. One to three injections are necessary. Five to seven days after the severe local and general reaction, there is subjective and objective improvement of the symptoms. In fifty cases followed for two years, lasting improvement was obtained in eighty-four per cent. The treatment is suggested as an adjunct to the usual orthopaedic measures.—*Walter P. Blount, M.D., Milwaukee, Wis.*

Traitement du Pied—Bot Equin dans la Paralysie Spasmodique (The Treatment of Pes Equinus in Spastic Paralysis). Ove Scheivel. *Acta Orthop. Scandinavica*, I, 152, 1930.

An historical summary of the treatment of spastic equinus is followed by a review of 335 cases and a statistical study of 136 operations over a six-year period. The results were about equal with tenotomy and open elongation of the Achilles tendon (fifty-nine and fifty-two per cent. good, respectively) but overcorrection was common with the former and recurrence with the latter. With neurectomies alone there were very few overcorrections, but there were recurrences in more than fifty per cent. When the nerves

to the heads of both the gastrocnemius and solius were cut in conjunction with open elongation, overcorrection resulted in thirty-six per cent. When the nerve supply to either one alone was removed along with open elongation, the best results were obtained. Neurectomy of the motor branches to the head of the gastrocnemius is advocated in this combination because of the probable advantage of transforming the triceps surae into a two-joint muscle.—*Walter P. Blount, M.D., Milwaukee, Wis.*

Coxa Valga Caused by a Separation of the Epiphysis. H. Scheuermann. *Acta Orthop. Scandinavica*, I, 178, 1930.

A case is reported in which coxa valga instead of coxa vara resulted from the slipping of the proximal femoral epiphysis in a girl of fourteen. The symptoms appeared suddenly during walking. Pain and grating led to x-ray examination, which disclosed the deformity. The symptoms subsided in two months with bed rest, but the valgus persisted. The writer suggests that such an occurrence is common enough to be listed among the causes for coxa valga.—*Walter P. Blount, M.D., Milwaukee, Wis.*

Über Ischiasskoliosen und Ähnliche Zustände (Sciatic Scoliosis and Similar Conditions.) Herman Wahren. *Acta Orthop. Scandinavica*, I, 183, 1930.

According to the newer concept of sciatica, there is a local factor which is often insignificant and difficult to prove clinically, and a general pathologic hypersensibility. The former may be only muscle fatigue or hyperactivity. Osteo-arthritis is too often considered the cause when it is really only the reaction of the organism to the lumbar insufficiency, just as the pain of sciatica is in a great number of cases a manifestation of this weakness. Scoliosis is a result of pain which causes muscle spasm. The faulty posture causes increased pain, and a vicious circle is established. Forty-two cases are tabulated in detail. In thirty-seven there was a list to the side opposite the pain, and in five a list to the same side.—*Walter P. Blount, M.D., Milwaukee, Wis.*

A Case of Multiple Cartilaginous Exostoses. Herman Wahren. *Acta Orthop., Scandinavica*, I, 236, 1930.

A typical case is reported in some detail with well reproduced x-rays appended. The findings agree in all details with Murk Jansen's description of the syndrome and fit in closely with his conception of mechanogenesis of the bony abnormalities. Thus, the metaphyses are markedly elongated, show striping and typical broadening as well as exostoses. One portion of the diaphysis of the humerus shows a light area in the x-ray. Poor development of the distal end of the ulna is also present. A large calcified enchondroma is present on the right femur. The case is especially interesting to the author because it corresponds to Jansen's "tubulation" (an interruption to the normal growth processes which ordinarily cause a transformation of metaphysis into diaphysis, resulting in lengthening of the metaphyseal region, exostosis, and bony markings).—*J. E. Milgram, M.D., Iowa City, Iowa.*

Results of 256 Tri-articular Arthrodeses of the Foot in Sequelae of Infantile Paralysis. Paul Giuldal and Thor Sodemann. *Acta Orthop. Scandinavica*, I, Fasc. 3, 1930.

Panastragaloid arthrodeses were performed. In 133 cases the operation was performed through the Kocher incision and 123 through a temporary resection of the external malleolus. The latter incision was followed by more rapid healing.

The operation was not performed before the age of twelve years. Fifteen to twenty degrees of plantar-flexion and slight valgus constituted the desirable position. Two years' observation, postoperative, was the minimum period accepted for inclusion in the series.

The results were functionally and anatomically good in 127, functionally good in eighty-five, improved in thirty-five, unaltered in seven, and aggravated in two. Of 174

patients who used appliances before operation, 164 have been able to discard them. Before operation only eleven could get along with ordinary footwear, and six of these had to use a foot plate; since operation eighty-nine are using ordinary shoes (22 use foot plates). Shortening up to four centimeters causes no difficulty. The varus deformity is the most difficult one to correct. Relapses occur into varus and inflexion with frequency.

Many of the patients complained of pains after marked exertion, which showed a tendency to disappear after some years. The pains are mostly localized to the instep. Trophic disturbances appeared in markedly paretic cases. Walking up hill was the most unsatisfactory situation encountered by these feet after operation.—*J. E. Milgram, M.D., Iowa City, Iowa.*

BILATERAL CONGENITAL DEFORMITY OF THE ASTRAGALOCALCANEAN JOINT.—BONY COALESCENCE BETWEEN OS TRIGONUM AND THE CALCANEUS? P. G. K. Bentzon. *Acta Orthop. Scandinavica*, I, 359, 1930.

In a case of painful bilateral flat-foot the absence of lateral mobility was explained by the x-ray finding of a triangular bony process extending cephalad from the tuber calcanei to the ankle joint. This projection occupied the space of the processus posterior tali, which was entirely lacking on one side. The writer considers the condition to be due to a fusion of the os trigonum with the calcaneus.—*Walter P. Blount, M.D., Milwaukee, Wis.*

ÜBER EINE EIGENARTIGE, WAHRSCHEINLICH BISHER NICHT BESCHRIEBENE OSTEOBLASTISCHE KRANKHEIT IN DEN LANGEN KNOCHEN DER HAND UND DES FUSSES (Concerning a Characteristic Osteoblastic Disease of the Long Bones of the Hand and the Foot, Presumably Hitherto not Described.) Hilding Bergstrand. *Acta Radiol.*, XI, 596, 1930.

Two cases are described. The first, in a girl of sixteen years, presented a two months' history of swelling of the right foot. A flat foot was present, and aside from local tenderness over the enlarged second metatarsal bone no signs were elicited. The x-ray revealed an irregular thickening, the entire shaft of the second metatarsal, most marked proximally, apparently layered on the old cortex. After six weeks' observation without improvement the metatarsal was resected under the presumptive diagnosis of sarcoma.

The second case occurred in an eighteen-year-old chauffeur, who for two years had noticed an increasing enlargement of the basal phalanx of the left middle finger. Removed for a sarcoma, no recurrence appeared after three years.

The pathological pictures of both specimens were the same. On transverse section, in the center of each specimen was seen a central zone of amorphous collagenous substance surrounded by a ring of spongy bone. From this zone, bone vessels and so called osteoblasts seemed to have invaded the central mass. Basophilic cells were numerous. There were no cartilage cells suggestive of an enchondroma, nor were there evidences of a common inflammatory reaction.

The author is inclined to the opinion that these two cases represent cartilaginous rests (each was located near a cartilage plate earlier in life) which possibly, as the result of trauma, underwent destruction followed by vascularization.

What would have occurred in these two cases without operation is a matter for conjecture. Enlargement caused pain however.—*J. E. Milgram, M.D., Iowa City, Iowa.*

ROENTGENOLOGIC FINDINGS IN A SERIES OF SEVENTY-TWO CASES OF TRAUMATIC MYELITIS DUE TO FRACTURE OF THE SPINE. E. S. Gurdjian. *Am. J. Roentgenol.*, XXV, 65, Jan. 1931.

Some very interesting cases are included in this list; in three of them where there was definite spinal cord injury, roentgenograms of the spine failed to show any bony

lesions to explain the clinical findings. In another group of cases the level of the spinal injury did not correspond with the spinal cord segment involved.

Longitudinal fractures through the bodies of the vertebrae are also shown. The author feels, as I am sure we all do, that lateral films should always be taken in cases of suspected spinal injury.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

MENISCUS CALCIFICATION: ROENTGEN FINDINGS IN DISEASE OF THE MENISCI. Martin Israelski. *Am. J. Roentgenol.*, XXV, 85, Jan. 1931.

Meniscus calcification usually has its onset in patients of middle life and is most often bilateral without any relation to trauma. In some of the cases no discomfort is caused.

Metabolic disturbances seem to play a part in the etiology; in the reported cases, one had diabetes and the other gout.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

TUBERCULOSIS OF THE INTERVERTEBRAL ARTICULATIONS. Howard P. Doub and Carl E. Badgley. *Am. J. Roentgenol.*, XXV, 299, Mar. 1931.

Two types of vertebral tuberculosis can be recognized early,—the central involvement of the body and the involvement of the anterior portion of the body. The present paper describes a third type of tuberculosis of the vertebral bodies in which the diagnosis is very often not made. This type has been called epiphyseal tuberculosis of the body of the vertebra because it involves the area of the body in which the epiphysis occurs. The authors believe that a better name for this third type is "intervertebral articular tuberculosis".

Three cases of this latter type are reported, and the pathological and roentgenologic changes are gone into carefully.

The authors feel that young adults having low back pain should be very carefully gone over for the possibilities of spinal tuberculosis, and anterior-posterior and lateral skiagraphs made of the whole spine, as they have found that the pain symptoms were all below the level of the region involved.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

IRREGULAR OSSIFICATION OF THE EXTREMITIES OF BOYS AND GIRLS. Ruth Otis Sawtell. *Am. J. Roentgenol.*, XXV, 330, Mar. 1931.

This is a very instructive paper comprising roentgenograms of the hands of 367 boys and 350 girls from one to eight years of age, and 119 roentgenograms of the feet of children in New York. Tables were made of irregularities in the bones. It was found that irregularities in the ossification of the extremities are frequently found in skiagraphs of normal children.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

FRACTURES OF THE ANTERIOR SUPERIOR PORTION OF THE OS CALCIS DUE TO INDIRECT VIOLENCE. H. W. Dachtler. *Am. J. Roentgenol.*, XXV, 629, May 1931.

Twenty-six cases of this fracture since 1920 are reported. All these fractures were caused by the same type of injury. A platform truck with heavy small wheels carrying loads of 1000 to 2000 pounds is pulled from the front and pushed by one or two men from the rear. The injury was caused by the forward end of the truck running up on the posterior aspect of patient's ankle; the leg was forced forward, flexing the foot. The author states that patients were usually ready for full duty in two months, and that none of them has attempted to claim any permanent disability.

The article is well illustrated.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

SPONDYLOLISTHESIS, WITH A REPORT OF FOUR CASES. S. Kleinberg. *Am. J. Surg.*, X, 521, Dec. 1930.

All four cases showed a dislocation of the fifth lumbar vertebra due to congenital deformity of the posterior arch. The author feels that trauma does not play the part formerly supposed, and that the pathogenesis is lack of fusion of faulty development of

the posterior neural arches. Trauma might further separate these faulty structures, and the superimposed body weight causes the typical deformity and symptoms. Faulty formation of the superior surface of the sacrum may be a contributing factor, with an increased lumbar curve and abnormally long lamina, as seen in lateral views of the spine.

In severe cases traction of the lower extremities in flexion relieves the pain in back and legs but does not reduce the dislocation. In cases where there is a break in the bony wall of the neural arch, spinal fusion is needed to relieve symptoms. In case of elongation of the laminae, external spinal support should be used, reserving spinal graft for use if conservative means fail.—*Custis Lee Hall, M.D., Washington, D. C.*

HALLUX VALGUS: ITS CAUSE AND SIMPLIFIED TREATMENT. J. M. Hiss. *Am. J. Surg.*, XI, 51, Jan. 1931.

The author says that (1) hallux valgus is not an enlarged joint; (2) broken arches and hallux valgus are the result of the same forces working on the foot; (3) there is a phylogenetic set-up for hallux valgus; (4) hallux valgus is the result of tendon imbalance across the great toe joint; (5) hallux valgus can be corrected without removing the head of the great metatarsal bone.

The removal of the great metatarsal head and sesamoids is condemned as not correcting the deformity and the muscle imbalance. After osteophytic overgrowth is removed, and the insertion of the abductor tendon relocated, the adductor tendon and lateral capsule are tenotomized. Skin closure involves mesial elliptical capsulectomy which not only removes the proliferating cartilage but takes up capsular slack. Excess skin is removed in the same way, including the bursa, the whole operation being done under procain (1 per cent.) infiltration. Excess weight-bearing on the great toe joint can be relieved by treatment of the arches.—*Custis Lee Hall, M.D., Washington, D. C.*

OPERATION FOR THE RELIEF OF RECURRENT DISLOCATION OF THE SHOULDER: WITH PRESENTATION OF PATIENTS. T. Nicola. *Am. J. Surg.*, XI, 119, Jan. 1931.

The author describes his operation, which is the best of the surgical procedures devised for this condition and has been done on about twenty cases with uniformly excellent functional results. The operation was first described in *The Journal of Bone and Joint Surgery*, XI, 128, January, 1929. A brief review is given of the types of cases and anatomical considerations, together with some additional points added since the original article. Four cases are added in which operation was performed by the author, who states that the operation is simple to perform; it can be used in all cases, no matter whether bony, capsular, or muscular; there is practically no restriction of motion at the shoulder after operation; and the period of convalescence is short.—*Custis Lee Hall, M.D., Washington, D. C.*

SUBLUXATION OF THE HEAD OF THE FIBULA. M. S. Burman. *Am. J. Surg.*, XI, 108, Jan. 1931.

Forty cases of dislocation of the head of the fibula have been collected from the literature. To these the author adds another.

He gives the clinical symptoms and physical findings in a case report of a boy, age seventeen, who complained of the presence of a bony prominence on the outer side of his knee which he had sustained in a sixty-yard dash. He noticed a dull pain and stiffness in the knee the day after the race, and these symptoms lasted a few days. The pain is dull, and located between the head of the fibula and the tuberosity of the tibia.

Examination of right knee showed an increased prominence of the head of the fibula. Motions in the upper tibiofibular joint were increased; motions of knee normal. As the knee moved from full flexion to full extension, the head of the fibula was seen to subluxate at ninety degrees flexion, and to remain so until 160 degrees extension was reached. There was definite and marked tenderness over the head of the fibula when it was subluxated, none when it was self-reduced.

He explains the mechanism of the injury as follows: It was probably due to the tearing or stretching of the external joint capsule while the boy was running, was due to a strong inadvertent inward rotation of the leg with inversion of the foot, the knee being extended.—*L. T. Waring, M.D., Iowa City, Iowa.*

EXPERIMENTAL JOINT TUBERCULOSIS. (1) An Attempt to Produce Localized Lesions in Guinea-pigs. Wm. J. Spring. *Am. Rev. Tuberculosis*, XXIII, 333, Apr. 1931.

The author's summary is as follows:—

Three types of human tubercle bacilli of varying virulence were injected in varying measured doses into the knee joints of guinea-pigs previously sensitized by infection with tubercle bacillus of low virulence.

Tuberculous lesions of the synovia, and in some cases of the bone marrow, were produced, the severity of the lesions apparently depending more on the virulence of the micro-organism than on the dose within the range examined.

The organism virulent enough to produce regularly joint lesions of appreciable severity usually caused severe visceral tuberculosis.

In view of the wide individual variations between animals treated alike, the lesions produced are of no use for therapeutic experiments.—*Clarence A. Ryan, M.D., Vancouver, B. C.*

EXPERIMENTAL JOINT TUBERCLOSIS. (2) Comparative Effects of Tuberculous Infection in Normal and Previously Infected Guinea-pigs. Wm. J. Spring. *Am. Rev. Tuberculosis*, XXIII, 346, Apr. 1931.

Following a single measured dose of tubercle bacilli, injected into the knee joint, tuberculous guinea-pigs showed clinically an immediate inflammatory reaction more severe and of longer duration than that shown by normal animals.

Secondary joint reactions occurred in the sensitized animals more gradually and, on the average, later than in previously normal animals.

The average severity of joint involvement was somewhat greater in the previously normal animals.

The author concludes that "the response of the guinea-pig's knee joint to tuberculous infection, primary or secondary, is essentially similar to that reported in other tissues".—*Clarence A. Ryan, M.D., Vancouver, B. C.*

FRACTURES AT THE CONDYLES OF THE FEMUR. Condict W. Cutler, Jr. *Ann. Surg.*, XCIII, 551, Feb. 1931.

This is apparently an accurate study of thirty-eight cases, covering a period of thirty years. The group has been subdivided for study. *First*, fractures above the condyles,—eighteen such cases were treated. All the patients were in varying degrees of shock. Manipulation and skeletal traction were the methods of choice. Casts were then applied for six to eight weeks. *Second*, fracture between the condyles,—knee-joint involvement; there were seven of this type. None showed the Y formation with wide separation of the condyles. The hazard of infection was great and grave. *Third*, fracture of internal condyle,—there were three such cases, all occurring in patients of middle age. Reduction was done under anaesthesia. *Fourth*, fracture of the external condyle,—five cases. *Fifth*, separation of condylar epiphyses,—five cases; treated by manipulation; only two needed open reduction. There were early satisfactory results in ten out of eighteen cases; late satisfactory results in thirteen out of eighteen. The author points out the seriousness of this type of injury.—*C. S. Lowendorf, M.D., Iowa City, Iowa.*

FRACTURE OF THE SHAFT OF BOTH BONES OF THE LEG. Robert H. Kennedy. *Ann. Surg.*, XCIII, 563, Feb. 1931.

From a maze of statistics the summary clarifies the following points on 107 cases reported: Thirteen were spiral, nine involved the upper third, thirty-five the middle

third, fifty the lower third. Eighty cases were simple fractures, twenty-seven compound, sixty were comminuted fractures. The treatment consisted of plaster splints, skeletal traction, adhesive traction, and Ober operation. Callus was first noted after an average of forty days. Among the twenty-seven compound fractures, five had gas bacillus infiltration.

Final results on forty-two are rated, with the majority having good results.—*C. S. Lowendorf, M.D., Iowa City, Iowa.*

TUMORS OF THE GIANT CELL GROUP. C. F. Geschickter and M. M. Copeland. *Arch. Surg.*, XXI, 145, 1930.

Attention is directed to the histogenetic instead of the histologic aspects of these lesions. Trauma is the initial cause of the giant-cell tumor, its cutting off of the arteries proceeding inwardly from a cortical position at the epiphysis or metaphysis producing a subperiosteal hematoma. This deprives the cortical bone in these regions of its nourishment, and there is a call for a collateral circulation from the medulla. The result is increased activity of the osteoclasts, which physiologically and embryologically open up channels for budding capillaries, and their proliferation. An imbalance is created between bone destruction and bone formation, which would proceed if the circulation were intact. The unchecked hyperplasia of the osteoclasts produces the typical giant-cell-tumor tissue and the early phase of osteitis fibrosa or bone cysts,—*i.e.*, multinucleated giant cells within a stroma containing many round cells.

An endocrin imbalance may predispose to this pathology, especially the type associated with calcium and phosphorus metabolism, as in the case of the parathyroid glands.

There is believed to be a relationship between the giant-cell tumors of the long bones and skull, the epulis of the alveolar border, and the giant-cell tumors of the xanthoma group found in the tendon sheaths. The authors base their conclusions on an analysis of 400 cases.—*W. R. Hamsa, M.D., Iowa City, Iowa.*

SKELETAL METASTASES FROM CARCINOMA OF THE RECTUM. Arthur H. Aufses. *Arch. Surg.*, XXI, 916, 1930.

The author reports eight cases of skeletal metastasis in carcinoma of the rectum. A search of the literature reveals only sixteen reported cases. In commenting on the twenty-four cases, the author notes that the various bones are involved with practically the same frequency as originally described by von Recklinghausen in 1891. The frequency and percentages were as follows:

Vertebrae	8	22.8 per cent.	Pelvis	2	5.7 per cent.
Femur	6	16.8 per cent.	Sacrum	2	5.7 per cent.
Ribs	6	16.8 per cent.	Radius	1	2.8 per cent.
Skull	3	8.4 per cent.	Scapula	1	2.8 per cent.
Sternum	3	8.4 per cent.	Ulna	1	2.8 per cent.
			Humerus	2	5.7 per cent.

F. G. Vieira, M.D., Iowa City, Iowa.

THE MANAGEMENT OF GIANT-CELL SARCOMA OF THE VERTEBRAE. John O. Bower, J. H. Clark, and Leon Davis. *Arch. Surg.*, XXI, 313, 1930.

The authors review the twenty-eight cases reported in the literature of metastases of apparently benign tumors of the epulis type to the vertebrae. They report their own case, treated successfully; the patient is well after five years. They come to the following conclusions:

1. Giant-cell tumors of the vertebrae should not be considered, as in other bones, to be benign.

2. These tumors rarely possess a tendency to metastasize; they recur commonly, and invariably produce cachexia.

3. Radical removal is contra-indicated, due to close proximity to the spinal cord and nerve roots; any interference stimulates to increased activity.

4. X-ray diagnosis is often at fault; if a lesion presents involvement of the vertebrae, rapid extension, clear intervertebral discs, and early symptoms of a cord lesion, a malignancy must be considered.

5. The best treatment is the insertion of radium into or near the growth with as little trauma as possible.—*W. R. Hamsa, M.D., Iowa City, Iowa.*

THE USE OF LOCAL ANAESTHESIA IN THE TREATMENT OF FRACTURES, WITH CONCLUSIONS DRAWN FROM FIFTY CASES. John P. Hosford. *British J. Surg.*, XVIII, 546, Apr. 1931.

Anaesthesia by novocain may be obtained (1) by infiltrating all tissues in the region of the fracture, (2) by injecting novocain into the hematoma around the fracture, (3) by injecting the nerves on the proximal side, (4) by injecting the brachial plexus, and (5) by using spinal injection. Two per cent. novocain without adrenalin is used, the solution being made up fresh at the time. The quantity in the series reported varied from ten to 144 cubic centimeters, but usually about twenty cubic centimeters for Colles' fractures, forty to fifty cubic centimeters for Pott's fractures, and twenty to forty cubic centimeters for fractures of the tibial shaft.

The advantages lie in the facts that the surgeon does not need an anaesthetist; the patient gets quick relief from pain; the muscle spasm is abolished, so that reduction may be accomplished; the cooperation of the patient is secured; the patient can be made to demonstrate the degree of correction which has been made; and further correction and fixation can, if necessary, be made under the same anaesthesia.

A series of fifty cases has been treated in this way by the author. In one, the anaesthesia was a failure; in two, it was only partially satisfactory. The others were successful and there were no complications, either from novocain poisoning or from sepsis. A brief outline is given of ten cases in which it was used.

CONCERNING THE PATHOLOGY OF TUMORS OF TENDON-SHEATHS. E. S. J. King. *British J. Surg.*, XVIII, 594, Apr. 1931.

The nomenclature of tumors of tendon-sheaths has become confused by too much emphasis on the type of cells found and the gross appearance rather than on the origin of the cells of the tumor. Reference is frequently made to the foamy or xanthoma cells and to the giant cells. It is suggested that the term "teno-synovioma" be used for the group as a whole, with subdivisions describing the type of cells making up the tumor.

Originally, the synovial lining was considered to have an epithelial origin. This gave way to the endothelial idea which was disproven by Lubosch in 1910. He demonstrated that the synovial membrane is a specialized connective-tissue surface, and this theory is now generally accepted. Fleissig brought out the interesting fact that many of these tumors, particularly the giant-cell variety, are not neoplastic but the result of chronic inflammation.

These tumors occur most frequently in the hand, along the course of a tendon. Development is slow, usually without pain, and frequently a history of trauma can be obtained. The flexor tendons of the right hand is the favorite site. The majority are benign, but others are very malignant and may invade muscle, lymph glands, liver and lung.

The typical cell of the benign tumor is a spindle cell and these show gradations into spheroidal cells. There may be considerable fibrous tissue. The "foamy" cells are spheroidal cells containing fat droplets. Giant cells of the foreign-body type also appear. In places the cells resemble cartilage. Definite spaces, lined by tumor cells, are found in tissue of all types, and in some there is an apparent secretion. In the malignant form the cells are more embryonic.

The normal histology of synovial membranes is discussed, with the resemblance of the tumor cells to the normal cells. Finally, the following classification of teno-synoviomata is suggested: (1) malignant; (2) benign, subdivided into (a) fibrous, (b) cartilaginous, (c) fatty, (d) vascular, (e) osseous, (f) mixed (these may contain giant cells or foamy cells).

INTERARTICULAR SYNOVIAL FOLDS. J. C. B. Grant. *British J. Surg.*, XVIII, 636, Apr. 1931.

The author's attention was first called to this subject by a dissection of the transverse carpal joint in the dissecting room. In this specimen was found a broad, apron-like fold of synovial membrane projecting from the posterior part of the capsule and lying between the two rows of bones. Further investigation was made on specimens of all limb joints except the hip joint. The same condition was found in all,—at all ages from birth to seventy-seven years, and all in normal joints.

Care had to be taken that proper fixation of the joint had occurred before it was opened. Drawings are shown of this condition in the ankle, carpus, elbow, tarsus and radiohumeral joint. In the latter joint the synovial fold, composed of fibrocartilage, occupied a position much like the semilunar cartilage in the knee.

The findings are important, for they are not generally recognized. These folds undoubtedly play an important part in trauma to the joints, with resulting adhesions or infections. The fact that they are found in cadavera of the stillborn as well as in the aged makes it appear that they are congenital and not acquired structures.

THE CLINICAL RESULTS FOLLOWING THE OPERATION OF SYMPATHETIC RAMISECTION. N. D. Royle. *British Med. J.*, II, 628, Oct. 18, 1930.

This was the most important paper read at the symposium on surgery of the sympathetic system before the British Medical Association Meeting in Winnipeg. It records the author's experience based on 600 operations. The results are based upon replies to a questionnaire and depend upon the judgment of patient or parent. They are as follows:

	Good or excellent result
Congenital spastic paraplegia	75.6 per cent.
Congenital spastic hemiplegia	71.4 per cent.
Congenital spastic chorea	70 per cent.
Acquired spastic hemiplegia	58 per cent.
Acquired spastic paraplegia—(four cases) (due to disseminated or lateral scoliosis)	100 per cent.
Parkinsonian rigidity	27 per cent.
Chronic constipation or megacolon in adults—five cases)	100 per cent.
Raynaud's disease—seven cases	100 per cent.
Buerger's disease—six cases	66 per cent.
Writer's cramp—one case	100 per cent.
Sarcoma of femur—one case—temporary improvement	

A number of other conditions are reported upon, including five cases of retinitis pigmentosa. All the latter were improved.—*R. I. Harris, M.B., Toronto, Canada.*

THENAR AND HYPOTHENAR TYPES OF NEURAL ATROPHY OF THE HAND. J. Ramsay Hunt. *British Med. J.*, II, 642, Oct. 18, 1930.

Hunt discusses a syndrome he first described twenty years ago,—*viz.*, paralysis of the motor branches of the median or ulnar nerve in the hand. The injury is occupational and gives rise to a paralysis of the small muscles of the hand, limited either to the median or ulnar distribution. In the ulnar type the palmaris brevis escapes. There is no accompanying anaesthesia.—*R. I. Harris, M.B., Toronto, Canada.*

THE AFTER-HISTORY OF HEALED SURGICAL TUBERCULOSIS. E. D. Telford. *British Med. J.*, II, 812, Nov. 15, 1930.

In a brief paper Telford summarizes the results of his twenty-six years' experience in the treatment of cases of surgical tuberculosis by conservative measures,—rest and fixation (heliotherapy is not mentioned). Between 1906 and 1924, 170 patients were discharged apparently cured after treatment of tuberculosis of the larger joints. Of these 129 were traced. The results of his inquiry are as follows:

In good health with no sign of activity in the old focus and no new disease—110 cases.

Complete arrest of the disease but functional result not good—seven cases.

Original disease still active or with appearance of new foci—six cases.

Died (with one exception of pulmonary or renal disease)—six cases.—*R. I. Harris, M.B., Toronto, Canada.*

CONGENITAL DISLOCATION OF THE HIP—LATE RESULTS OF TREATMENT BY MANIPULATION. E. Laming Evans. *British Med. J.*, II, 1035, Dec. 20, 1930.

Evans summarizes the results of treatment by manipulative reduction in twenty-five cases of congenital dislocation of the hip (1903 to 1930). The results are classified as: bad, one; poor, two; good, thirteen; perfect, nine. Based on this experience his conclusions as to treatment are as follows:

"Manipulative reduction at the earliest age should be employed. In children under two or two and one-half the reduction can usually be obtained with the greatest ease whilst gently stretching the adductors. In older children, if an early reduction is not obtained, two further attempts at intervals of seven to ten days should be made, when reduction without force will usually be possible. After three unsuccessful attempts, capsulotomy is indicated in order to deal with the obstruction of soft parts. If, after successful reduction, redislocation occurs from failure of growth of the superior and posterior borders of the acetabulum, the border should be levered over the head and held by a bone graft. The age limit for manipulative reduction is seven to eight in unilateral, and five to six in bilateral cases. In cases beyond these age limits open reduction is indicated."—*R. I. Harris, M.B., Toronto, Canada.*

A METHOD OF EXCITING INCIPIENT MOVEMENT IN WEAKENED AND PARALYZED MUSCLES. A. E. Porritt and O. F. Guthrie Smith. *British Med. J.*, I, 54, Jan. 10, 1931.

The authors eliminate all checks to the activity of the weakened muscles by counterbalancing the weight of the limb, inducing a relaxation of the opponent muscles, and finally counteracting almost entirely inertia, friction, and gravity. This allows the minimal feeble efforts of the affected muscles to act, not in the stationary limb, but in association with pendulum movements, maintained by the operator at first and later by the patient. The apparatus used is essentially an overhead bar with ball-bearing pulleys, through which run adjustable ropes and slings.

The principle is used in recent fractures. The limb is hung by adjustable slings from the horizontal bar above, and is then swayed in the various planes, all forces being counterbalanced as exactly as possible. The muscles now perform their lever movement more easily. Smooth action and regular rhythm dispel nervous tension and fear. The same method is used in poliomyelitis. As the arm swings to and from the body, the rhythm is taken up by the muscles, and the deltoid action is timed to take place at the most advantageous moment. As the muscles begin to recover, purposeful movements are introduced, such as hitting the elbow against a drum.

In spastic paralysis, the same principle is applied.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

THE DOMAIN OF ORTHOPAEDIC SURGERY. Sir Robert Jones. *British Med. J.*, I, 295, Feb. 21, 1931.

This paper is the substance of Sir Robert's presidential address to the International Society of Orthopaedic Surgery delivered in Paris in October 1930. In it he outlines

briefly the development and scope of the field of Orthopaedic Surgery as it exists in Great Britain today. A considerable amount of attention is paid to the development of the speciality which resulted from the War. Under the great need which then existed, orthopaedic hospitals were established in which were segregated for special treatment all cases of: (1) fractures—recent, malunited, and ununited; (2) deformities of the extremities and of the spine; (3) diseases, derangements, and disabilities of joints, including the spine; (4) injuries to peripheral nerves. This field of surgery has continued to be defined as the domain of the orthopaedic surgeon. He makes a powerful plea for preventive measures of crippling deformities, especially rickets and tuberculosis.—*R. I. Harris, M.B., Toronto, Canada.*

MANIPULATIVE REDUCTION OF CRUSH FRACTURES OF THE SPINE. R. Watson Jones. *British Med. J.*, I, 300, Feb. 21, 1931.

Jones describes a method of reducing and managing compression fractures of the spine. In principle it is very similar to the method described by Davis but there are important modifications. Reduction is effected by hyperextension without an anaesthetic. No manipulation is used. The patient is suspended face down and supported by his thighs and shoulders. His own weight causes such hyperextension as to reduce the fracture. An accurately fitting plaster jacket is applied in this position. From the third day on, exercises to strengthen the erector spinae are carried out, and on the tenth day the patient is allowed up. Within six months he should resume his normal occupation. Jones has treated by this method seven patients in whom the fracture was of less than a month's duration. One patient died of uraemia complicating paraplegia. In the remaining six cases reduction was completely successful. He makes an important point when he says that during first-aid treatment these patients should be lifted and carried in the prone and not the supine position.—*R. I. Harris, M.B., Toronto, Canada.*

RECONSTRUCTION OF THE FOREARM AFTER AMPUTATION OF THE HAND. A. K. Henry. *British Med. J.*, I, 393, Mar. 7, 1931.

Henry describes the results in two cases of an ingenious reconstruction operation upon the forearm, designed to give to the patient a prehensile member after amputation of the hand. Essentially the operation consists of the construction of a spur of bone projecting at an angle from the lower end of the radius. When this is completely fused to the radius by new bone, the patient by pronating his forearm is able to appose the new digit against a similar digit carried on a prosthesis. By this measure he is able to hold objects and to write.—*R. I. Harris, M.B., Toronto, Canada.*

HALLUX VALGUS: A NOTE ON OPERATIVE TECHNIQUE. P. B. Roth, *British Med. J.*, I, 443, Mar. 14, 1931.

Roth describes what he regards as the essential features of an ideal operation for bunions. He discusses first the choice of patient. Age is no bar. Occupation which involves standing all day he regards as inimical to function after operation,—this seems to indicate that there is need for a more perfect operation. The operation is essentially the Mayo operation of removal of the head of the metatarsal, but without the interposition of the bursa. After-treatment he regards as important. He applies extension to the great toe and corrects the deformities of the remaining toes by manipulation.—*R. I. Harris, M.B., Toronto, Canada.*

THE TREATMENT OF BONE TUMORS. E. I. Bartlett, *California and West. Med.*, XXXIII, 877, Dec. 1930.

The author reviews the early radical treatment of all tumors of bone. Two classifications of tumors are submitted,—one based on origin and one on prognosis. He believes the latter of more value to the clinician. This classification is as follows:

1. Benign—curable.
   a. Osteogenic
      (1) exostosis
      (2) osteoma
      (3) chondroma of phalanges
      (4) fibroma
   b. Inflammatory conditions
      (1) osteoperiostitis
      (2) osteitis fibrosa (bone cyst)
2. Malignant—incurable.
   a. Osteogenic sarcoma
   b. Ewing's tumor
   c. Myeloma
   d. Angiosarcoma
   e. Metastatic tumors
3. Borderline—hopeful.
   a. Central chondromyxosarcoma (except phalangeal)
   b. Atypical sarcoma

In the benign group, conservative methods are successful. In the malignant series, treatment is immaterial, inasmuch as all therapeutic agents are inadequate. Citing Connor's statistics of 1926, eleven cases or twenty per cent. of the fifty-four cases of Ewing's tumor then registered remain well to this date. Treatment consisted of surgery, x-ray radiation, radium, Coley's serum, or combinations of the above. Among the osteogenic sarcomata, there are thirty-four cures out of 125 registered cases, all followed five years after the last treatment. All these were of extremities and treated by amputation, only one being a disarticulation. The borderline cases include that group, but exclude the central chondroma of the phalanges which is usually benign. Chondromatous tumors, or any tumor where predominating cells resemble the cartilage cell, belong rather in the benign group.

In the discussion, mention is made of the relative radiosensitivity of the endothelial myeloma of Ewing; this is slightly less in the chondrosarcoma, while the myxosarcoma is very resistant as are all tumors containing considerable myxomatous tissue. Belief is expressed that where a diagnosis cannot be made by clinical evidence the following features should be borne in mind:

Conservative amputations or wide resections.

Exploratory operations in atypical cases.

X-ray treatment while diagnosis is being made, thereby giving it a trial as well.—*W. R. Hamsa, M.D., Iowa City, Iowa.*

THE KIRSCHNER METHOD OF SKELETAL TRACTION IN THE TREATMENT OF FRACTURES. R. R. Fitzgerald. *Canadian Med. Assn. J.*, XXIV, 83, Jan. 1931.

The author discusses rapid traction and continuous or prolonged traction. Steinmann pins and Preison's calipers are considered. He next gives Kirschner's method, wherein piano wire is passed through the bones. The causes of infection are mentioned. To eliminate the dangers in the preliminary drilling of the bones, Kirschner perfected a device for driving the sharpened wire itself through the skin, soft tissues, and bones. This lessens the trauma, abolishes skin incision and preliminary drilling. No dead space is created. The ends of the wires are clamped to a U-shaped stirrup.

The technique for applying the wire in the various fractures is given.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

SPÄTERGEBNISSE DER SEHNENVERPFLANZUNGEN (Late Results of Tendon Transplantations). Magnus Cohn. *Deutsche Ztschr. f. Chir.*, CCXXX, 220, 1931.

The author has made an extensive analysis of results of tendon transplantation. Of 111 cases subjected to operation at the surgical clinic at Göttingen, seventy-two were

examined after one to eighteen years following operation. The results of 100 operations performed upon these seventy-two patients were classified as follows: good, twenty-eight per cent.; definitely improved, forty-seven per cent.; unimproved, twenty-five per cent. Of the unimproved cases the majority are still under treatment.

The operative procedures were all employed to relieve disabilities of the feet, with the exception of five in the upper extremity and five for paralytic quadriceps extensor.—*R. J. Dittrich, M.D., Wichita, Kansas.*

ZUR BEHANDLUNG DES SPASTISCHEN PLATTFUSSES MIT INTRAMUSKULÄRER NOVOCAINEINSPRITZUNG UND VEREISUNG DES NERVUS PERONEUS (Treatment of Spastic Flat-foot with Intramuscular Injections of Novocain and Freezing of the Peroneal Nerve). Alfred Lilienfeld, *Deutsche Ztschr. f. Chir.*, CCXXX, 301, 1931.

The author's method of treatment consists of injecting novocain (50 to 70 cubic centimeters of a 0.5 per cent. solution) into the pronators and extensors. This produces relaxation of the muscles; it is followed by application of a plaster cast to hold the foot in a corrected position. After eight days the cast is removed, and physiotherapy, consisting of application of heat, massage, and exercises, is instituted. In addition, corrective shoes are worn. This form of treatment may be repeated several times.

In case of failure, the peroneal nerve is exposed under local anaesthesia and frozen by means of ethyl chlorid. By freezing the nerve for two minutes, a complete loss of sensation and motor power is produced. After two to three months, motion and sensation begin to return, and after six months full function of the nerve is restored.

By these two forms of treatment, good results are usually obtained in the type of flat-foot due entirely to muscular fixation. In cases with ligamentous fixation, results are less satisfactory. If, in addition to muscle spasm, bony changes are present, the novocain injection is ineffective, and freezing of the nerve can produce only improvement.

The author has made a detailed analysis of forty cases which had been treated from two to six years previously. In nineteen cases of flat-foot due purely to muscular spasm, cures were obtained in fourteen (73.7 per cent.).—*R. J. Dittrich, M.D., Wichita, Kansas.*

GIBT ES "PERSISTIERENDE WIRBELKORPEREPIPHYSEN" (Are There Such Things as "Persistent Vertebral Epiphyses")? Pathologic-anatomic comments on the articles of Hanson, Janker, Michajlow, and Tscherepnina. Herbert Junghanns. *Fortschr. a.d. Geb. d. Röntgenstrahlen*, XLII, 704, 1930.

The author emphasizes again the necessity of familiarizing oneself with the newer knowledge of anatomy of the growing vertebral body (Schmorl's publications 1928–1930). The authors upon whose papers he comments have mistaken the origin of the shadows near the anterior edges of the vertebrae in the adults they have examined. Instead of being persistent epiphyses, Junghanns points out, they are exostoses or fractures of the bodies or more often calcification in the ligaments following avulsion in injuries. Occasionally, shadows appear to be in the disc in the lateral view. They are really in the surrounding ligaments. It is important in adjusting compensation claims not to interpret these as "persistent epiphyses".

As a matter of fact, in all the vast material of Schmorl's anatomic-pathologic museum no "persistent epiphyses" exist. The marginal ledge of bone present as a distinct triangular shadow in the lateral view of a child's spine is at twenty-five years of age completely fused with the body, so that the junction cannot be recognized in the x-ray. To be sure, even in old age a line on the outer aspect of the body indicates the point of junction. It is only in cretins that failure of ossification of this marginal ring has been observed.

The author emphasizes Schmorl's dislike of the term "vertebral epiphysis". Neither morphologically nor physiologically is it comparable to ordinary epiphyses. "Marginal ledge" or "marginal band" is a much more accurate term.

The illustrations are reproduced with the usual excellence of this journal.—*J. E. Milgram, M.D., Iowa City, Iowa.*

ZUR KLINISCHEN BEDEUTUNG DEFORMIERENDER PROZESSE DER WIRBELSÄULE (A Contribution to the Clinical Significance of Deforming Processes of the Spine). Robert Gantenberg. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, XLII, 740, 1930.

The author's material of over 1200 observations is tabulated in graphic form. The patients are divided into miners, factory employes, craftsmen, and a group of women and children under fourteen years. In each group the number of cases showing spondylarthritis in the x-ray was charted against years figured in decades. The incidence of arthritis was much higher in miners than factory workers, and was higher in the groups who were subjected to hard labor. In each group a marked increase in the fourth and fifth decades, especially the latter, over preceding decades is to be observed from the charts.

As to evaluating the x-ray findings as far as symptoms are concerned, the author finds that x-rays, while regularly overestimated in such cases, should be considered only as adjuncts in reaching opinions as to compensation. Sacro-iliac and back pains appear frequently in miners without x-ray evidence as well as with such evidence. No correlation between the severity of spur formation and the severity of symptoms can be found. Limitation of motion and subjective symptoms are more important. They are more likely to be an expression of a functional injury or exhaustion of the supporting muscular apparatus of the spine, or,—and this appears often in miners,—a true muscular rheumatism. In addition, a true rheumatic spondylarthritis may be present.

In spite of all exceptions, it is not to be forgotten that a fully developed spondylitis deformans, especially when accompanied by limitation of motion, can cause sacral and back pains. Critical evaluation of local and general signs and symptoms together with the x-rays are necessary.—*J. E. Milgram, M.D., Iowa City, Iowa.*

COXA VARA OF THE ADOLESCENT. Discussion of the paper presented by George Huc at the Twelfth Annual Congress of the French Orthopaedic Society, Paris, October 10, 1930 (Lecture by A. Steindler, M.D., Iowa City, Iowa).

A. Mouchet and C. Roederer: The speakers take issue with the distinction between adolescent and infantile coxa vara, which they do not think justified, either clinically or radiologically. They point out, from the viewpoint of pathology, that the torsion of the head mentioned by the essayist has the effect of prematurely limiting the flexion, and offers certain difficulties to correction. The authors take issue with the essayist's method, ascribed to Ombredanne, of measuring the deforming of the head by the line uniting the equidistant points. Another point they take issue with is the prognosis of the coxa vara, especially since many of these hips produce secondary arthritis. The speakers further point to the endocrine factors which maintain an important rôle, although the fact of overweight and muscular pressure seems to be of prime importance. It seems that most of the oppositions of the authors rest upon the fact that Huc's observations do not tally with an article by Mouchet and Roederer, published shortly before. The description of Huc's coxa vara of infancy, the speakers believe, often refers to the true congenital coxa vara which has been recognized long since by Drehmann.

Huc: In discussing the infantile coxa vara, the same author describes it also as a typical reaction to different etiological causes, but totally different from that of the adolescent age. It is a juxtatrochanteric deformity, whereas the former is a deformity of the femoral head. It follows other affections,—rickets, infections, traumatism—as the former group, and it is, therefore, a symptomatic condition. Initial symptoms rarely attract attention in the course of the first months; it is usually during the beginning of the gait, often later (at the age of five or six years), that a slight limp attracts attention. The axis of the femur is found normal, there is little or no outward rotation or abduction; also, the angle of declination of the forward twist of the femur is within normal limits. One outstanding symptom is the lordosis. It gives the condition the appearance of congenital dislocation of the hip, except that one finds the head of the femur bent downward, the bend occurring at the cervicotrochanteric junction. This decreased inclination angle may be as low as forty-five degrees. The greater trochanter dominates the

neck, with its base implanted at the upper circumference. This upward projection of the greater trochanter explains the functional insufficiency of the gluteus medius muscles with the ensuing symptoms of lameness. It is noticed that the epiphyseal cartilage has its normal form and normal sharp outline. When one follows the axis of the neck, one observes the kinkage of the axis placed at the junction between neck and intertrochanteric region and not, as in the adolescent coxa vara, between neck and head. In respect to treatments the author advises in the beginning stages rest and continued extension; in older cases, bone plastic operation, bone graft, osteotomies, etc. Attention is also paid to the anatomical distribution of vascularization of the upper extremity or of the femur, which explains the distribution of infectious and necrotic processes, according to whether the cervicotrochanteric or the cervicocapital blood supplies are primarily affected. In the entire treatise, coxa vara is treated as a symptom and not as a clinical condition, and it is especially emphasized that infectious, traumatic, metabolic, and endocrine conditions are alike able to produce the same features in the x-ray films.

Froelich: Of greater interest is the discussion of Froelich, a real authority on coxa vara. He believes that the coxa vara of adolescence should be called the essential coxa vara, because in adolescence there exists also a symptomatic coxa vara, such as traumatic. The essential coxa vara is a spontaneous epiphyseal separation, or traumatic separation of the femoral head. At first there is no real coxa vara, since the angle between the axis of the neck and the axis of the diaphysis is not modified. Later, however, exuberant ossification, which occurs in the course of the detached, backward and downward, displaced head, produces a true coxa vara deformity. The essential coxa vara is, therefore, always cervical. The symptomatic coxa vara is trochanteric.

The treatment of the complete separation of the head is reduction by the Whitman method, sometimes assisted by nailing. Froelich believes that the cause of the essential coxa vara is an infection; sometimes the endocrine glands have an indirect influence. The essential coxa vara is, therefore, an epiphysitis of the upper end of the femur, localized at the intermediate epiphyseal cartilage, whereas the osteochondritis deformans juvenilis is an epiphysitis of the entire femoral head.

Loose Bodies in the Elbow-joint; Their Origin. G. Söderlund. *Hygiea*, XCII, 752, Oct. 15, 1930.

The author describes four cases of loose bodies in the elbow joint. In three of these the loose body was fractured, which could be verified by roentgenograms in two of the cases.

The author associates himself with the view pronounced by Barth, later by Roesner, Häuptli, and above all by Kappis, that osteochondritis dissecans is a purely traumatic subchondral disruption of cartilage or cartilaginous bone splinters from articular surfaces in knee and elbow joints.—*Harald Nilsonne, D.M., Stockholm, Sweden.*

Upon the Technique of Plaster-of-Paris Dressing in Fractures. Maurtiz Persson. *Hygiea*, XCII, 769, Oct. 31, 1930.

In the treatment of fracture of the long bones one occasionally meets with an angular displacement of the fragments after the plaster has been put on. In these cases, instead of removing the plaster, reducing, and putting on a fresh plaster, the author has in recent years adopted the following procedure.

1. Roentgen examination in two right-angled planes, usually frontal and sagittal.
2. Measuring on the skiagram the angle between the axis of the lower fragment and the prolongation of the axis of the upper fragment (angle of deviation).
3. Transversely cutting through by saw the plaster at the level of the seat of fracture, the whole of the plaster being included, barring a four to five centimeter broad bridge on that side toward which the angle between the fragments is directed.
4. Forcing apart the plaster until a desirable angle is obtained and a wedge of cork can be inserted.

5. Control under roentgenogram.
6. Reenforcement of the plaster by starch and plaster bandages.

Twelve cases have been treated by this method, and the angle of deviation has been fully corrected.

The author further describes a method by which, with the aid of the angle of deviation in two right-angled planes verified by the roentgenogram, one is able mathematically to estimate the size of the true angle of deviation, and also the plane in which the angle is lying in relation to the frontal and sagittal planes.—*Harald Nilsonne, D.M., Stockholm, Sweden.*

SUBCUTANEOUS NODULES IN RHEUMATOID (Chronic Infectious) ARTHRITIS. M. H. Dawson and R. H. Boots. *J. Am. Med. Assn.*, XCV, 1894, Dec. 20, 1930.

The occurrence of specific subcutaneous nodules in rheumatic infection has long been an established fact, but little attention has been paid to their presence in rheumatoid arthritis, a disease in which they are an even more striking phenomenon.

The authors have observed these nodules in approximately twenty per cent. of the 200 cases of rheumatoid arthritis that have come under their care; they have never been seen in osteo-arthritis. They vary from seed-like bodies to olive-sized excrescences, most commonly on the dorsal surface of the forearm about four centimeters distal to the olecranon. They are usually discrete, subcutaneous, and as a rule unattached, but show a relationship to tendon sheaths and bursal walls. The larger ones may persist for a long time while the smaller ones may run an acute course. They are found in severe cases and generally spell an unfavorable prognosis, but are never painful.

Fourteen nodules were microscopically studied and showed a characteristic picture of central necrosis, a surrounding zone of radially arranged large mononuclear cells, with an enclosing zone of dense, relatively avascular, fibrous tissue. The surrounding tissue, arterioles, and capillaries show an active part in the process of an inflammatory nature. The bacteriologic investigations were entirely negative.

These nodules have no relationship to the nodules occurring in lues, gout, or tuberculosis, but are strikingly like those found in rheumatoid fever and, therefore, favor the theory that these two diseases are different manifestations of the same fundamental disease process.—*J. Kulowski, M.D., Iowa City, Iowa.*

DEVELOPMENTS IN THE PROBLEM OF ARTHRITIS. Ralph Pemberton. *J. Am. Med. Assn.*, XCVI, 33, Jan. 3, 1931.

The writer stresses especially the intricate systemic ramifications of the body economy significant of arthritis, and urges the profession to consider each individual case upon this essential premise.

Recent new developments are summarized as follows:

1. The two great types are the atrophic and hypertrophic varieties.
2. Foci of infection, though their importance should not be lessened, may be the background of the condition and not the cause.
3. The disturbances of the finer blood supply, essentially an irregularity and sluggishness, are of great biologic significance, as has been definitely shown experimentally and clinically. This is apparently brought about through the intermediation of the nervous system by "virtue of inherent weakness in it, imbalance of it, or the influence of intoxicating factors operating centrally or peripherally on it".

Since 1912 the writer has emphasized the etiologic rôle of the intestinal tract and the food intake.—*J. Kulowski, M.D., Iowa City, Iowa.*

THE TABETIC ARTHROPATHIES. Arthur Steindler. *J. Am. Med. Assn.*, XCVI, 250, Jan. 24, 1931.

This study is based upon sixty-four cases of arthropathy, involving ninety-nine joints. Of these cases possibly three were non-tabetic.

It is of interest to learn that other conditions besides tabes may and do produce similar arthropathies; anterior poliomyelitis, syringomyelia, fractures of the spine, hematomyelia, peripheral nerve lesions, and spina bifida. Experimental observations support the theory of the superimposition of external mechanical factors upon the neurogenically weakened joint in the pathogenesis of this condition. Pathologically, the hypertrophic, proliferating, and the degenerative types may be all stages of one progressive lesion and may even be seen side by side in the same joint.

"In general, arthropathy is characterized by cartilage erosion, chip fractures and compression fractures, flattening and condensation of the joint bodies, marginal proliferations, intra-articular and extra-articular exostoses, and ossification of the ligamentous and muscular structures. . . . Effusion comes and goes," and, if it persists, helps to increase joint relaxation. Syringomyelia involves mostly the upper extremities.

Recent work shows that microscopically the pathology begins primarily in the cartilage. Destruction and absorption by catabolic processes take place from both sides of the cartilage, causing a honeycombing. The same observer has shown that inactivity atrophy of cartilage takes place wherever pressure is relieved, and proliferative changes result where abnormal static stresses prevail. There is also a rejuvenation of the activity of the normally stationary preliminary calcification zone just beneath the joint cartilage which underlies the proliferative and absorption elements of this condition. Mechanical forces further engrafted upon this activity finally bring about the eburnated, disintegrated end result so commonly seen. The ossification of periarticular structures further exemplifies the tissue reaction to stress and strain, and is rather compensatory. Those tissues relieved from this show osteoporosis.

The x-ray pathology is strikingly exhibited and may be specifically interpreted in the light of the pathology. Forty-seven of the joints showed free bodies.

Trauma played a definite part in the onset in twenty-five cases, while in others it aggravated the condition. In eleven cases the joint complaints were primary. Joint symptoms usually come on many years after the infection. About half the cases were seen in the pre-atoxic stage, which bears out the observations of others. This is pertinent to orthopaedic treatment, especially regarding the reeducation of the muscles. In sixteen of the joints pain was predominant, especially in the traumatic group.

In the treatment it is most important to make the diagnosis in the pre-atoxic stage, followed by adequate mechanical or operative protection. Forty-two cases were treated conservatively and of these twenty-four improved. Twelve cases were operated upon; of these nine joints improved.—*J. Kulowski, M.D., Iowa City, Iowa.*

TREATMENT OF GANGRENE DUE TO THROMBO-ANGIITIS OBLITERANS. Saul S. Samuels. *J. Am. Med. Assn.*, XCVI, 751, Mar. 7, 1931.

Gangrene which often occurs during the course of thrombo-angiitis obliterans is a self-limiting process. Extreme conservatism, even in the severest forms of gangrene, is usually rewarded with an intact extremity, the value of which no one will question. Amputation of a leg should be advised only when it appears that the gangrene will destroy so much tissue that a non-functioning foot will be the ultimate outcome. Pain is no indication for amputation.

Rest in bed, cessation of smoking, cleansing baths, the application of anaesthetic ointments, and the intravenous administration of large amounts of fluids are the essentials in the conservative treatment of gangrene due to thrombo-angiitis obliterans.—*W. B. Carrell, M.D., Dallas, Texas.*

ROENTGENOGRAPHIC STUDIES IN NORMAL OSSEOUS DEVELOPMENT. E. Kost Shelton. *J. Am. Med. Assn.*, XCVI, 759, Mar. 7, 1931.

The author presents a very interesting article on the osseous development. A practical and modern set of tables and roentgenograms of the normal osseous development for every year of age from birth to twenty years is published; also the opinions of

other observers in regard to their variations. The author feels that sex plays a very important part in these variations and that the standard tables are of practical value in the differential diagnosis of the endocrinopathies.—*W. B. Carrell, M.D., Dallas, Texas.*

SYMPATHETIC RAMISECTION IN SPASTIC PARALYSIS: END-RESULTS OF SIXTY CASES. W. B. Carrell. *J. Am. Med. Assn.*, XCVI, 849, Mar. 14, 1931.

In a group of sixty cases there were eighty-three ramisections, twenty-three cervical and sixty lumbar. Observations were made over a period of two to five years. Some of the patients had other operations, as foot stabilizations and Stoffel's, prior or subsequent to the sympathetic operation. Each operation was credited with the proportionate result.

The cervical cases operated upon, exposing the rami as they join the brachial plexus, gave unsatisfactory results. The author states in a foot-note that in recent cases, following trunk section below the stellate ganglion, there was temperature change in all cases and definite improvement in some.

In the lumbar cases, none showed improvement immediately after operation; some were not improved at any time. Some were improved twenty-five per cent. to forty per cent.; the average gain was sixteen per cent. The factors influencing good results were chiefly related to the mentality of the patients,—age, sex, type, and plegia apparently were of slight consequence in selection of cases which might be benefited.

The author concludes that trunk section or ramisection is of definite value as one of the measures in the treatment of properly selected cases of spastic paralysis, and that an improvement of sixteen per cent. to twenty-five per cent. may be expected beyond that now secured by other recognized plans of treatment.

The author reports experimental work on goats in an attempt to corroborate the effects reported by Royle and Hunter. The conclusion was that on goats sympathectomy does not influence the rigidity of decerebrate specimens.—*P. M. Girard, M.D., Dallas, Texas.*

TRANSFUSION DONORS AS SOURCES OF IMMUNE SERUM FOR TREATMENT OF POLIOMYELITIS. Harold K. Faber. *J. Am. Med. Assn.*, XCVI, 935, Mar. 21, 1931.

The author makes the following suggestions in the use of human immune serum for the treatment of poliomyelitis:

1. It is advisable to test for viricidal properties those samples of human serum intended for the treatment of poliomyelitis. Pooled serums may have low or inadequate amounts of immune antibodies, owing to the inclusion of non-immune serums and consequent dilution of the immune fractions. The tests, though expensive, are entirely practicable.

2. State or municipal boards of health might be charged with the duty of making such tests or of defraying the expenses when performed by such private agencies as properly equipped private research institutions.

3. Adult transfusion donors are frequently immune to poliomyelitis, and their blood, when tested and found to contain viricidal properties, forms an abundant and readily available source of serum for treatment. The testing of transfusion donors for such immune properties whenever and wherever possible is strongly urged.

4. The availability of transfusion donors for the treatment of poliomyelitis suggests the possibility of using large amounts of immune blood by direct transfusion in severe cases as a means of obtaining prompter and more thorough therapeutic action than is afforded by intramuscular or intrathecal injection.—*W. B. Carrell, M.D., Dallas, Texas.*

ANTIPOLIOMYELITIS HORSE SERUM: ITS PREPARATION AND USE. Marcus Neustaedter. *J. Am. Med. Assn.*, XCVI, 933, Mar. 21, 1931.

In 1910 Flexner reported failure in an attempt to immunize a horse against poliomyelitis. Knowing that different horses might react differently, the author began in August of 1916 injecting a horse with filtrates of brain and cord suspension made from

children who had died of poliomyelitis. After a number of years of this treatment it was found that the serum from this horse protected several monkeys from the disease while the controls promptly died of poliomyelitis. Later three more horses were similarly treated and an equally potent immunizing serum developed.

The serum is of greatest value clinically when given in the preparalytic stage. Therefore, the author thinks that in all suspected cases a complement fixation test or spinal fluid should be done for early diagnosis.—*W. B. Carrell, M.D., Dallas, Texas.*

TRAUMATIC ULNAR NEURITIS DUE TO STRAPPING OF THE ELBOW AND THE FOREARM TO THE OPERATING TABLE. E. S. Gurdjian. *J. Am. Med. Assn.*, XCVI, 944, Mar. 21, 1931.

A case of traumatic ulnar neuritis is added to the literature. The trauma was due to strapping of the elbow to the operating table. Ten months later ulnar transposition relieved the patient of his symptoms.—*W. B. Carrell, M.D., Dallas, Texas.*

THE PRACTICE OF TRAUMATIC SURGERY. John J. Moorhead. *J. Am. Med. Assn.*, XCVI, 1191, Apr. 11, 1931.

There are certain phases of traumatic surgery peculiar to it alone.

1. There is no incubation period. The injury to the tissue is immediate. There is no time for the tissue to build resistance.
2. Trauma produces an immediate effect; therefore, if the treatment is to concern the trauma and not trauma plus complications, it must be immediately applied.
3. Traumatic cases are unlike general surgical conditions such as an appendectomy in that they require a constant follow-up.
4. Operations in a traumatized area are more likely to become infected.
5. Trauma is no respector of rank, sex, race, age, or anatomic zones.
6. Traumatic cases are almost always medicolegal cases.
7. End results, good or bad, in these cases are much more obvious than in the ordinary surgical case.
8. Three-fourths of all traumatic cases fall into the group of contusions, wounds, burns, joint injuries, fractures, and dislocations.

In the management of these cases the following principles improve results:

1. Treatment within six hours of injury.
2. Early mobilization.
3. Infrequent dressings to minimize secondary infection.
4. Delayed operations in infections, using hot, wet dressings while waiting for localization.
5. Open operations in fractures and dislocations only when simpler methods fail.
6. More universal use of local or general anaesthesia in the more severe injuries.

The author gives directions for the treatment of specific injuries, emphasizing the fact that restoration of function, union, and contour is the aim of the traumatic surgeon. He favors the adoption of some universal method of grading various disabilities, and makes definite suggestions in this direction.—*W. B. Carrell, M.D., Dallas, Texas.*

CONGENITAL PLEXIFORM NEUROFIBROMAS AND ELEPHANTIASIS NEUROMATOSA OF THE RIGHT ARM AND NECK (Von Recklinghausen's Disease): Supplementary Report. F. P. Anzinger. *J. Am. Med. Assn.*, XCVI, 1381, Apr. 25, 1931.

The author adds a supplementary report to the literature in a case of Von Recklinghausen's disease reported in 1919. At birth patient appeared normal. One year later complained when right arm was handled. Subcutaneous removal of fibrous cord in arm gave considerable relief. In the course of years the whole right upper extremity grew in noticeable disproportion to that of the left. The skin became pigmented and thickened, simulating an ordinary elephantiasis.

Patient is now twenty-one; roentgenograms show trophic changes and atrophy.—*W. B. Carrell, M.D., Dallas, Tex.*

THE INTERVERTEBRAL DISC. Emil S. Geist. *J. Am. Med. Assn.*, XCVI, 1676, May 16, 1931.

The author quotes the quite extensive researches of Professor Schmorl in calling attention to the importance of the intervertebral disc in relation to disease and injury of the spine.

In a man six feet in height, five inches is taken up by the discs. The central portion, or nucleus pulposus, has an internal pressure, like fluid under tension, and following disease or injury may expand or prolapse with clinical symptoms. This prolapse or apparent displacement of a part of the osseous body by cartilage was found to exist in thirty-eight per cent. of 3000 spines of cadavera studied by Schmorl. The author checked a number of clinical back cases and found the condition present frequently. It may be isolated or multiple. The defense reaction is shown by the spongy bone in the formation of spicules or lamellae of bone around the area of prolapse.

Knowledge of the function and pathology of intervertebral discs will require further study of some back injuries now accepted as an involvement of the bony structures alone.

—*W. B. Carrell, M.D., Dallas, Texas.*

ON THE INCIDENCE OF BOVINE TUBERCLE BACILLI IN HUMANS. Clarence A. Ryan. *J. Michigan Med. Soc.*, XXX, 11, Jan. 1931.

Twenty-five strains of tubercle bacilli isolated from tuberculous lesions (bone and joint) in twenty-two children and three adults were typed, using the traditional criteria: type of growth, acid production, and pathogenicity for rabbits. Although all the strains were recovered from the type of lesions in which the incidence of bovine bacilli is usually high, none of these twenty-five strains was found to be a typical bovine bacillus.

A METHOD OF REDUCING SUPRACONDYLAR FRACTURES OF THE HUMERUS. R. Y. Paton. *Lancet*, II, 1180, 1930.

Sir Robert Jones' method is as follows: The surgeon should grasp the child's wrist with the right hand and place the left hand around the upper arm, so that the thumb puts pressure on the lower end of the upper fragment, just above the elbow. The forearm should be extended and pulled in order to disengage the lower fragment. When this has been done the forearm should be supinated, and while the pull is maintained the arm should be flexed while the upper fragment of the humerus is pushed back. The arm should be flexed to thirty degrees, or as near to thirty degrees as the swelling will allow.

When this method fails the author advises the following: The injured limb is raised with the humerus vertical, the hand and forearm being flexed toward the chest. The hand is steadied by an assistant. The surgeon interlocks his fingers around the flexor aspect of the humerus and so grasps the humerus firmly. The thumbs are placed vertically side by side on the dorsal aspect. Keeping the humeral shaft absolutely steady in the fingers, the surgeon now exerts pressure with his thumbs upward and forward on the lower fragment and guides it to its proper position. If the lower fragment is impacted, it is disimpacted by increasing the deformity,—*i.e.*, extension at the elbow joint. When there is lateral deviation more pressure is exerted by the appropriate thumb to correct it. The assistant maintains the position as it improves,—with the arm supinated. When the reduction is complete, there is about thirty degrees of flexion. This is maintained by slinging the wrist under the chin. No splint is necessary.

He cites the advantages of this method.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

COMPLETE ANTERIOR DISLOCATION OF BOTH BONES OF THE FOREARM AT THE ELBOW. REVIEW OF RECORDED CASES AND LITERATURE WITH REPORT OF A CASE. Max Michael Simon. *Med. J. and Record*, CXXXIII, 333, Apr. 1, 1931.

The author reports a case of complete anterior dislocation of both bones of the forearm at the elbow, making a total of thirty-two recorded in the literature. Of these,

eight cases occurred through fracture of the olecranon and should more properly be considered as fractures than as dislocations. The cause in the greater number of cases was a fall on the flexed elbow. In all cases verified by operation or autopsy, an extensive laceration about the joint and a stripping of muscle in that vicinity was found. The case reported by the author was that of a boy, seventeen years of age, whose right arm had been caught in an extracting machine. The arm was greatly swollen, deformed, and blue from the elbow down to the finger tips. No radial pulse could be felt. The elbow was fixed in a position of about 145 degrees with the hand in semipronation. There was no evidence of nerve injury. There was a compound fracture of the shaft of the ulna and radius at the junction of the lower and middle third with anterior dislocation of both bones forward on the humerus. Three months after the injury the elbow was stable with about twenty degrees of motion. Reduction may be accomplished by flexing the limb within a right angle and pulling the upper ends of the bones back into place while the upper arm is steadied by an assistant. If reduction does not result from this procedure, a study of the mechanism of the injury should be made, and an attempt to follow the movements in the reverse direction will result in reduction.—*Robert Zollinger, M.D., Cleveland, Ohio.*

Akuter Gelenksrheumatismus und Tuberkelbazillämie (Acute Rheumatic Arthritis and the Tubercle Bacillus). Karl Reitter and E. Lowenstein. *Münchener Med. Wchnschr.*, LXXVII, 1522, 1930.

In an acute polyarthritis following pneumonia, or during the course of a gonorrhoeal or luetic inflammation, the etiology is clear. But there is a large group in which the etiology is not clear, which group we call rheumatism. One of these authors has shown, as Poncet described, that a large number of these cases are tuberculous; the other author, that in the joint exudate in fifteen cases, tuberculosis could be demonstrated. Both authors have shown that tubercle bacilli can be recovered from blood cultures. Their investigations show that not only is this important, but also that nearly all cases of so called acute polyarthritis are tuberculosis. He considers that the cases of rheumatic endocarditis should also be proven pathogenic,—anatomically as well as clinically.

A series of nine case reports is then given in which the cultures were positive for tuberculosis. The authors do not believe the relationship between the bacteriemia of tuberculosis and the complications such as endocarditis, pericarditis, pleuritis, etc., to be a coincidence, for it was possible to show tuberculosis in the aspirated material from the knee joint, also pure cultures of tuberculosis could be procured from this and from the blood. These findings were repeated and controlled.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

Zur Behandlung der Brüche des Schienbeinkopfes (On the Treatment of Fractures of the Tibia). R. Syller. *Münchener Med. Wchnschr.*, LXXVII, 1586, 1930.

The mechanism of the condition is discussed, with types of fractures. Exact anatomical reposition is stressed. Pressure methods from either side have not been successful. Even open wiring has not given the best functional result. He follows a procedure similar to that advised by Böhler, who advised extension of the bones at the calcaneus with manual compression to replace the fragment; when necessary, the elevation of the most distal fragment by a Steinmann nail. He analyzes the ten cases which were treated in the clinic. In cases of split fracture, dislocation occurred; in these cases the Böhler method was not successful in procuring a good position. Manual compression was unsuccessful, as was also the elevation of the fragment by a nail. For this reason they proceeded to manufacture a compression machine for the above purpose, modeled after the osteoclast of Schultze; it has the advantage, however, of having pressure caps which fit the condyles of the tibia on either side and thus great pressure is attained. They give a picture of the instrument.

Then follows a complete description of the technique of reduction. The essentials are anaesthesia; extension through the calcaneus or both bones of the leg by the Böhler

apparatus; aspiration of blood in the knee joint if present; application of pressure against both condyles by the compression machine; application of plaster, which includes the toes and extends to the upper thigh. The extension and the plaster are left for eight weeks, but the position is controlled every four weeks. After this a plaster cast is extended to the pelvis, giving relief to the knee, as the weight of the body is now borne by the ischium. After fifteen weeks have elapsed, physiotherapy is instituted. Four weeks more elapse before active weight-bearing is allowed. The long fixation in plaster does not produce unfavorable results and, with Böhler, he stresses good reposition and good consolidation before early movement. Results were perfect. In one patient who was allowed to bear weight at the end of eight weeks there resulted redislocation, severe disturbance of mobility, and severe arthritic changes. There have been no untoward results with the compression machine. The author closes with insistence upon a long period of immobilization, the desirability of avoiding too early strain on the callus, etc.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

Die Behandlung der Chronischen Polyarthritis im Spätstadium (The Treatment of Chronic Polyarthritis in the Late Stages). Jacques Kroner. *Münchener Med. Wchnschr.*, LXXVII, 1670, 1930.

The author points out that the personality of the doctor and hope for improvement are necessary aids to the treatment. We must realize that this is a general disease, in which local manifestations occur in the skeletal system, muscles, and nerves.

The general treatment is discussed very fully. The nutrition of the patient, especially as most of these arthritic patients are undernourished and anaemic, must be thoroughly investigated. Appetizers are given; the diet should be rich in all the vitamins; cod liver oil is advised, and arsenical preparations for the anaemia. The work of Whipple, Minot and Murphy, on liver treatment, not only in pernicious anaemia but also in secondary anaemia, is considered. Either liver or liver extract is given. Air and sunshine in abundance are needed.

On the contrary, in the fat, plethoric type of arthritis we must reduce the intake of nourishment. The intake of fluids should also be regulated in these cases. Schroth's diet is discussed. This restricts the fluid intake, is poor in salt content, and only rich in carbohydrates in the form of bread or gruel. Freund, Krebs, and others quote good results with this.

Kroner discusses the use of mineral waters. He gets good results especially in plethoric cases. In those cases where mineral water is not at hand, the various preparations of mineral salts are advised. The beneficial effect of the salts is noticeable, namely uricedin, also the strongly alkaline effect in the successful working on the acid-base-balance of the arthritic patient. He considers the symptomatic treatment of pain by salicylate and atophan preparations; and points out that this is important. Lying in bed only makes the condition worse. As F. Munk has said, "A chronic arthritic does not belong in bed".

The local treatment for pain consists of the application of liniments, the value of which depends not only on the analgesic and hyperaemic effects, but also on the speed and amount of resorption. Incandescent-lamp treatment and diathermy are discussed. The heat-ray baths at least give temporary relief in severe arthritis. Light massage is stressed, especially where the muscles are atrophic, where the tendons and nerves are the seat of the pain. Massage and sketchy gymnastics on the part of the patient are given.

Hormonotherapy is considered fully. Opotherapy is of service in those cases in which the joint involvement dates from the time of the climacterium; ovarian preparations are used. In the other cases foci of infection and head colds are considered. Ovarian hormones are used. Hydrotherapeutic measures are then considered, especially in the form of hot baths. He gives the temperatures of t' baths, and the periods of exposure advisable, depending on the severity of the condition. Various additions to the bath, such as salts or carbonic acid, are discussed. Where hormonotherapy is indicated,

this combined with salt baths gives very good results. Sulphur baths are very good. —*M. E. Pusitz, M.D., Iowa City, Iowa.*

SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM AND CHRONIC ARTHRITIS. Paul G. Flothow. *Northwest Med.*, XXIX, 518, Nov. 1930.

While sympathectomy is not advocated as early treatment of progressive arthritis, before the removal of foci of infection and the use of all therapeutic measures, progress of this arthritis is a definite indication for this operation. Five cases are reported, all in advanced stages, with marked bony periarticular changes, four having added involvment of the joint surfaces. The ages ranged from twenty-one to fifty-seven; duration of the disease was from six to fourteen years. In all cases, relief of pain and increase in joint function was noted.

For the lumbar ganglionectomy, the lumbar approach of Royle was used in preference to the abdominal approach, its advantages being speed of performance, extra peritoneal exposure, and absence of shock. For the dorsal sympathetic ganglionectomy the posterior approach (Henry - Adson) was preferred over the anterior approach (Royle), its advantage being the ability to completely denervate all sympathetic fibers to the brachial plexus. Leaving the inferior cervical ganglion intact has produced only a temporary Horner syndrome, one of the advantages ascribed to the anterior approach.— *W. R. Hamsa, M.D., Iowa City, Iowa.*

CONCERNING SUPERNUMERARY BONES IN THE REGION OF THE ELBOW JOINT. B. Fainberg. *Orthopaedia i Travmatologia*, III-IV, 41, 1930.

Two cases with definite supernumerary bone formation in the elbow are described. In one case each elbow showed a round, very regular, small bone situated to the inside of the internal condyle of the humerus. In the other case a unilateral supernumerary bone was found medially and below the internal condyle of the humerus. The author discusses briefly the different points of view on the existence of these bones, points out their practical importance in the differential diagnosis of injuries about the elbow joint, and comes to the conclusion that his observation also confirms the existence of these bones as supernumerary formations about the elbow joint.—*Emanuel Kaplan, M.D., New York, N. Y.*

A METHOD OF PELVIS FIXATION FOR TRACTION IN FRACTURES OF THE LOWER EXTREMITIES. R. Bakuschinsky. *Orthopaedia i Travmatologia*, III-IV, 46, 1930.

To secure good fixation of the pelvis for traction, the author uses a plaster-of-Paris mold of the anterior part of the pelvis with a transverse bar incorporated in the plaster. Another transverse bar is attached under the bed with two uprights on each side of the bed. The patient is placed in bed, a sand bag under his pelvis and the plaster mold over it. The transverse bar of the plaster mold slips between the two upright bars on each side of the bed. The two transverse bars are then tied with a cord on each side of the bed.—*Emanuel Kaplan, M.D., New York, N. Y.*

A STUDY OF THE CHARACTERISTICS OF THE FOOT. S. Brandis. *Orthopaedia i Travmatologia*, III-IV, 81, 1930.

There is no accord as to the structure and functional differentiation of the anterior weight-bearing surfaces of the foot. The author emphasizes the value of exact planimetric measurements and offers a simplified geometric method. He finds that the etiology of the planovalgus deformity is complicated; age, constitutional weakness of the muscular and ligamentotendinous apparatus, as well as shoes, are important contributing factors. Between the ages of eighteen and twenty years the feet are susceptible to planovalgus changes, which are very marked and mostly observed between twenty-one and twenty-five years. The nationality of the patient plays no rôle, although there is a prevalence of this deformity among the peasant population.—*Emanuel Kaplan, M.D., New York, N. Y.*

Subluxation Volontaire de la Hanche en Arrière (Hanche à ressaut articulaire). Albert Mouchet. *Presse Méd.*, XXXIX, 195, Feb. 7, 1931.

The author reports one case of voluntary subluxation of the hip in a twelve-year-old girl which became painful after repeated subluxation. This condition is more infrequent than the ordinary "snapping hip" due to slipping of the iliofemoral band over the greater trochanter (Massiat). The symptomatology is similar in both conditions, and the differential diagnosis is important. The article is illustrated by radiographs.—*Emil S. Geist, M.D., Minneapolis, Minn.*

A Propos du Traitement des Pseudarthroses du Col du Fémur. Jacques Leveuf. *Presse Méd.*, XXXIX, 204, Feb. 11, 1931.

This is a good article, but somewhat controversial in nature and difficult to abstract.

Leveuf is of the Delbet Clinic and compares the results of this clinic with those of Dujarier in similar cases.

Both use the autogenous bone peg, which is obtained by removing a section of the fibula (Delbet method).

While Dujarier obtains only thirty-seven and five-tenths per cent. good results with this method in twenty-four cases, Leveuf in twenty cases gives the favorable statistics of ninety-five per cent.

Leveuf thinks that the best results can be obtained in fairly recent cases of non-union accompanied by a small amount of upper displacement and where there is little destruction by absorption of the femoral neck.

The author also passes in review the other operative methods used in cases of this type (reconstruction) but very much prefers the autogenous graft.—*Emil S. Geist, M.D., Minneapolis, Minn.*

Polyarthrite Symétrique Primitive a Évolution Chronique Progressive et Destructive Chez des Soeurs Jumelles. Jacques Ley et J. J. Snoeck. *Presse Méd.*, XXXIX, 264, Feb. 21, 1931.

This is a well written article describing two cases of chronic ankylosing polyarthritis in twin sisters. In spite of many forms of treatment, the disease gradually increased in severity.

The cases were followed and carefully studied for a considerable number of years, from childhood to adult life.—*Emil S. Geist, M.D., Minneapolis, Minn.*

La Physiothérapie dans le Traitement de la Poliomyélite. P. Duhem. *Presse Méd.*, XXXIX, 400, Mar. 18, 1931.

The author divides the treatment of poliomyelitis as follows:

1. The treatment of the nerve centers.
2. The treatment of circulatory troubles.
3. The treatment of the paralyzed muscles.
4. The treatment of the pain.

Regarding the first item, the author is in favor of ionization. Regarding the second, the author is in favor of balneotherapy and diathermy. Regarding the third point, the treatment of the paralyzed muscles, the author favors electrical stimulation above all. As far as the treatment of the pain is concerned, diathermy with baths and physiotherapy is recommended. The author is in favor of special hospitals for the treatment of poliomyelitis.—*Emil S. Geist, M.D., Minneapolis, Minn.*

Orientations Thérapeutiques dans le Rhumatisme Chronique les Arthrites. F. Coste, J. Forestier et J. Lacapère. *Presse Méd.*, XXXIX, 633, May 2, 1931.

This is a complete review of the treatment of chronic arthritis from the point of view of the internist. There is added nothing, new or startling, to our previous knowledge.—*Emil S. Geist, M.D., Minneapolis, Minn.*

QUELQUES REMARQUES SUR LES TUBERCULOSES CHIRURGICALES. Leur Fréquence, les Difficultés de leur Diagnostic. D'APRÈS LA STATISTIQUE DE L'HÔPITAL MARITIME DE BERCK (1920-30). Etienne Sorrel, Paul Bufnoir et Mlle. J. Fumet. *Presse Méd.*, XXXIX, 689, May 13, 1931.

In the opinion of the reviewer this is a very important statistical study. It deals with all the cases seen at the hospital at Berck from 1920 until 1930. The total number of cases was 9,512. Of these 7,095 were children and 2,417 represented adults. About two-thirds of the cases were of tuberculous nature.

The article must be read to be appreciated. One of the outstanding facts is the frequency of multiplicity of the lesion. The authors show that the tuberculous lesion is often multiple, and they have found patients who had involvement in even ten various locations.

Mortality is greatest in cases of Pott's disease, tuberculous osteo-arthritis of the elbow, and tuberculosis of the tibiotarsal joints. Tuberculosis of the knee presents a fairly low percentage of deaths.

One interesting point which is brought out is that postoperative generalization of the tuberculous process is comparatively rare.

The entire article is a careful analysis of a huge number of cases not heretofore reported as a group. It should not be overlooked by the writers of future textbooks in orthopaedic surgery.—*Emil S. Geist, M.D., Minneapolis, Minn.*

QUELQUES REMARQUES SUR LES TUBERCULOSES CHIRURGICALES. Evolution des Idées sur leur Traitement pendant la Derniere Décade. D'APRÈS LA STATISTIQUE DE L'HÔPITAL MARITIME DE BERCK (1920-1930). Etienne Sorrel, Paul Bufnoir et Mlle. J. Fumet. *Presse Méd.*, XXXIX, 731, May 20, 1931.

This is another statistical study from the Maritime Hospital at Berck comprising the years from 1920 to 1930. The authors' statistics agree with what seems to be the general sentiment in America today—namely, that in children operative intervention is to be little used while in the adult operative measures should be used with frequency and without fear. The authors' conclusions are certified by ample and most interesting statistics which it is impossible to reproduce here.

It is quite apparent that the authors lean very favorably to ankylosing operations of the spine, knee, hip, shoulder, and the other large joints. A large series of cases is reported together with end results.—*Emil S. Geist, M.D., Minneapolis, Minn.*

A STUDY OF 100 CASES OF BACKACHE. R. K. Ghormley. *Proc. Mayo Clinic*, V, 350, Dec. 3, 1930.

The causes of backache in 100 cases are tabulated as follows: Sacro-iliac affections, thirty-two per cent.; lumbosacral affections, twenty-three per cent. (of these, lumbosacral strain forms nine per cent., anomaly of fifth lumbar vertebra four per cent., narrow fifth lumbar vertebra four per cent., calcified iliolumbar ligaments four per cent., and spondylolisthesis two per cent.); arthritis of the hypertrophic type, twenty-four per cent.; postural strain, five per cent.; old fractures, four per cent.; old Pott's disease, three per cent.; scoliosis, two per cent.; Paget's disease, congenital anomaly of the first few lumbar vertebrae, metastatic malignant disease, congenital anomaly of sacrum, and tumor of cauda equina, five per cent.

The author doubts if there would be much variation in the final percentage, even though the series of cases be enlarged many times.—*C. M. Meng, M.D., Iowa City, Iowa.*

THE ROENTGENOLOGIC DIAGNOSIS OF BONE TUMORS. Charles F. Geschickter. *Radiology*, XVI, 111, Feb. 1931.

The information from examination of more than a thousand cases of bone tumors is organized and a diagrammatic chart drawn up, in one division of which any bone tumor will place itself by reason of certain characteristics.

The main divisions include:

1. Tumors occurring,
   (*a*) In patients under twenty.
   (*b*) In patients over twenty.
2. The tumor is,
   (*a*) Single.
   (*b*) Multiple.
3. The origin of the lesion is,
   (*a*) Medullary.
   (*b*) Periosteal.
4. The lesion is,
   (*a*) Bone destructive.
   (*b*) Bone formative.
5. The site is in the,
   (*a*) Shaft.
   (*b*) Metaphysis.
   (*c*) Epiphysis.
6. Pathological fracture,
   (*a*) Has occurred.
   (*b*) Has not occurred.
7. The configuration of the diseased area.

Graphic information is given in explanatory tables, drawings, roentgenograms and photomicrographs. The text gives an explicit description of each of the different tumors, its age incidence, locations, symptoms, course, duration, roentgen characteristics, and gross and microscopic appearances. The likelihood of pathological fracture is stated and the histogenesis discussed.

This seventy-page article contains such a wealth of detail that it is impossible for an abstractor to give more than a general description of it. It would be difficult to overestimate its value as a reference for anyone interested in the differential diagnosis of bone tumors.—*Edward N. Reed, M.D., Santa Monica, Calif.*

NON-SUPPURATIVE OSTEOMYELITIS. L. Clarence Cohn. *Radiology*, XVI, 187, Feb. 1931.

It is necessary to differentiate this condition from (1) sarcoma, (2) osteitis deformans, and (3) ossifying periostitis.

The article is a study of 105 cases of non-suppurative benign lesions of bone, from the Surgical Pathological Laboratory of Johns Hopkins University.

Classification:

Roentgenographic	*Etiologic*
Sclerosing	Traumatic
Ossifying	Syphilitic
Destructive	Post-typhoid, influenza, etc.
Osteoporotic	Infections from a distant focus.

Seventy-five per cent. of these patients were under forty years of age and thirty-three per cent. were under twenty years,—about the same age incidence as in sarcoma. A history of trauma was present in almost fifty per cent., a positive Wassermann in ten per cent., and a demonstrable focus of infection in ten per cent. Five per cent. followed typhoid, influenza, or rheumatic fever.

In seventy-five per cent. the lesion was single, in twenty-five per cent. multiple. In this connection it is noted that multiple sarcomata sometimes develop in Paget's disease.

As to location, the tibia and femur each were involved in twenty per cent., the humerus in eight per cent., and the pelvis, skull, and clavicle each in five per cent.

Radiographically, one-third of the non-suppurative osteomyelites resemble sarcoma. Bone destruction in this condition may be as extensive as in sarcoma and may go on to pathologic fracture. Most but not all of such cases are luetic in origin.

As to treatment, "When the x-ray suggests sarcoma, and when the tumor is radio-resistant, and when foci of infection are eliminated, we are justified in exploratory operation, provided the tumor, if malignant, is operable".—*Edward N. Reed, M.D., Santa Monica, Calif.*

BONE METASTASES: A STUDY OF 334 CASES. Murray M. Copeland. *Radiology*, XVI, 198, Feb. 1931.

Hypernephromata furnished the largest incidence of bone metastasis, thirty-four and nine-tenths per cent.; with carcinoma of the lung second, sixteen and six-tenths per cent.; carcinoma of the prostate third, twelve and eight-tenths per cent.; carcinoma of the testis next, seven and seven-tenths per cent.; carcinoma of the uterus, five and six-tenths per cent.; carcinoma of the breast, five and two-tenths per cent.; bone metastasis in other carcinomata are infrequent. Of these cases 100 were from primary breast cancers. The majority of the primary tumors (58 per cent. were of the scirrhous type, and the bones most frequently involved were spine, pelvis, femur, skull, ribs, and humerus.

Clinically there was usually severe rheumatic pain, and eventually a secondary anaemia. Seventy-five per cent. showed multiple bone metastases, most of the solitary foci being in a vertebra or femur. Most of the metastases were osteolytic, only two per cent. in this series being bone-forming.

Microscopic studies showed that metastases occur by the vascular route and by direct extension from other bones, through the lymphatics. There was evidence that bone reacts to invasion by attempts at production of new bone, and that x-ray therapy stimulates this osteogenetic reaction.

As to treatment: seventy-four per cent. of these cases of bone metastasis from breast tumors had had a radical amputation of the breast. The average time between appearance of the primary tumor and of the bone metastasis was thirty-two and five-tenths months; and between the radical removal and the metastasis thirty months, although a few appeared after the lapse of from nine to twenty years.

Eighteen per cent. had had subradical excision, with an interval of twenty-nine and one-tenth months between appearance of the primary tumor and of the metastasis, and sixteen and seven-tenths months between operation and metastasis.

Eight per cent. were inoperable, and in these the metastasis appeared in from one to twenty-four months after the primary tumor. The technique of x-ray treatment as used at Johns Hopkins Hospital is described.

Of those who had the radical operation followed by metastasis, the average duration of life after irradiation was eighteen months, while for those not irradiated it was eleven and five-tenths months. Two cases of this group have survived for seventy-one and forty-eight months respectively.

The average duration of life after subradical operation was sixteen and two-tenths months in those who received x-ray treatment, twelve and eight-tenths months for those who did not. Of the inoperable cases, those irradiated lived ten months and those without x-ray therapy seven and eight-tenths months. Resection did not prolong life but did relieve pain; while irradiation relieved pain and in some instances definitely prolonged life.

Metastases from hypernephromata involved, in order of frequency, the humerus, spine, femur, pelvis, ribs, feet, skull, sternum. Pathological fracture occurred in forty-five and four-tenths per cent. Metastases were single or multiple, and showed little tendency to bone production. X-ray was used in two cases, with relief of pain but without arrest of the disease.

Metastases from the prostate involved most frequently the pelvis and the vertebrae; more rarely the femur; and in two out of 134, the tibia and skull.

It is characteristic of prostatic metastases that they are predominantly osteoplastic. In this tumor irradiation relieved pain but did not prolong life. Bone metastases from uterine carcinomata were purely bone destructive, and were peculiarly unresponsive to irradiation, even for relief of pain.

Bone metastases from thyroid cancers were relatively frequent, and x-ray therapy gave relief of pain but no lessening of progress.—*Edward N. Reed, M.D., Santa Monica, Calif.*

AN X-RAY AND CLINICAL STUDY OF THE BONES OF THE HANDS AND FEET. Max Kahn. *Radiology*, XVI, 211, Feb. 1931.

One out of every ten neoplasms occurring primarily in bone involves the small bones of either the hands or feet.

This study is based on 145 lesions of the small bones, recorded in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, from 1890 to 1930. Of this number there were forty exostoses, about fifty per cent. involving the os calcis; usually single, they may be multiple, and are easily recognized in the x-ray film. Forty-five were chondromata, thirty involving the phalanges of the hands, fifteen the bones of the feet. None involved the carpals or metacarpals, in which benign giant-cell tumors and bone cysts are usually found. Usually single, they may be multiple and appear as a central expanded rarified or translucent area. Curettment, amputation, or excision usually cures; irradiation is not effective. Microscopically they consist chiefly of foetal cartilage and myxoma.

There were twelve cases of giant-cell tumor. Roentgenologically, a bone shell with expansion is seen, usually without trabeculation. Surgical treatment resulted in cure of practically all. There were nine cases of osteitis fibrosa, showing as small cysts with some bone expansion and trabeculation. The slight expansion and the trabeculation help to make the rather difficult differentiation from giant-cell tumor. Surgical treatment resulted in cure of practically all.

There were twenty cases of xanthoma of tendons and joints of small bones of the hands and feet. The x-ray findings are not characteristic. The microscope showed typical giant-celled areas in the tendons connected with the joints. There were three cases of sarcoma. One of these in the foot was excised. The patient died in less than a year, with multiple metastatic sarcomata of the lungs. There were six cases of carcinomatous metastases, there being in each case a generalized skeletal metastasis.

It is thus seen that malignant lesions in the small bones of the hands and feet are rare.—*Edward N. Reed, M.D., Santa Monica, Calif.*

BONE LESIONS OF THE LOWER RADIUS. Robert Lee Oliver. *Radiology*, XVI, 245, Feb. 1931.

In over 2000 bone lesions studied there were only fifty-six involving the radius, fifty of these being in its lower end. Of these forty-five were central lesions and five periosteal. Only four were malignant.

Non-suppurating osteomyelitis is infrequent but is difficult to differentiate from sarcoma.

Cohn says, "When the x-ray suggests sarcoma and the tumor is resistant to irradiation and where the foci of infection are ruled out, an exploratory operation is justifiable provided the tumor, if malignant, is operable".

Exostoses also are infrequent in the lower radius, although when multiple exostoses are present they affect the fibula or radius.

Chondromata are very infrequent in this area. There are a few bone cysts, with mild symptoms but frequently with pathological fracture.

The greatest number of the lesions of the lower end of the radius are giant-cell tumors. They show central expansion of the cortical bone, like bone cysts, but with asymmetrical contour. They, too, frequently develop pathological fracture. They frequently perforate their capsule, a complication which lessens the chance of cure.

The lower radius is the most common location for giant-cell tumor, followed closely in incidence by the lower femur and upper tibia,—fifteen per cent. of all the giant-cell tumors in the series occurred in the lower radius, and these constituted seventy per cent. of the lesions in this locality. Eighty-five per cent. were cured by curettment with thermal or chemical cauterization, with recurrence in fifteen per cent.

Osteogenic osteolytic sarcoma, Ewing's tumor, chondromyxo-sarcoma, and sclerosing sarcoma presented one case each; all were treated by amputation and all proved fatal.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Reduccion Espontanea de las Fracturas Supracondileas del Humero Mediante la Traccion Esquelética (Spontaneous Reduction of Supracondylar Fractures of Humerus by Means of Skeletal Traction). Lelio O. Zeno. *Revista Medica Latino-Americana*, XVI, No. 181, Oct. 1930.

Following a criticism of Sir Robert Jones's method of reduction of supracondylar fractures of the humerus, which the author judges antiphysiological, since hyperflexion of the forearm is not the position of neutral antagonistic muscular action—a principle maintained by Zuppinger—Dr. Zeno describes his method, reporting four of the five cases in which he has used it.

He considers this method as standard for the following reasons: it acts on the distal fragment; traction and countertraction are employed; it acts until union is obtained; allows a better functional prognosis as compression on vessels, nerves, muscles and other tissues is eliminated; hematoma and oedema are drained from the elbow. It also allows active motion without interference with the alignment of the fragments.

Operative technique. General anaesthesia is employed in children and local anaesthesia in adults. Transfixion of the posterior border of the ulna near the base of the olecranon process is made, using rigid wire. Beck's or Kirschner's tractors are used to obtain the desired tension on the wire. A weight of from one to two kilograms in children, and up to the necessary amount to keep the arm suspended in a vertical position, is attached. The forearm is flexed from fifty to eighty degrees. No manipulation for reduction is used; continuous traction alone is sufficient to obtain reduction. Pain in the shoulder is an indication of too heavy a weight. Circulatory conditions are immediately improved. Frontal and lateral x-ray views show excellent reduction. This traction is maintained for four or five days; then the arm is bandaged in flexion of from forty to seventy degrees. Skeletal traction is discontinued and the patient is allowed to leave his bed. The bandage is kept on for two or three more weeks; then active motion is encouraged.

Four cases are presented illustrated with radiograms and photographs of the lesions before and after treatment, showing the reduction of the fragments and the functional results.—*Alberto Inclan, M.D., Havana, Cuba.*

Fracture of the Shaft of the Femur. Duncan Eve, Jr. *Southern Med. J.*, XXIII, 813, Sept. 1930.

In fractures of the upper third of the femur, the suspension and traction method is used. In the middle third, if the fracture is transverse, a plaster cast is used. In the spiral and oblique fractures, suspension and traction are used. In the extreme lower third fractures, skeletal traction is used when displacement is present,—a Steinmann pin, through the condyles, with the knee flexed on a Pearson knee attachment. In children, plaster casts are usually used. Frequent x-ray examinations are used to check up on position.—*F. G. Hodgson, M.D., Atlanta, Ga.*

Synovial Fluid in Infectious and Neuropathic Arthritis. A. R. Shands, Jr. *Southern Med. J.*, XXIII, 818, Sept. 1930.

Data on fluid aspirated from 125 patients are given. In 105 cases of infectious arthritis studied, twenty-eight cases showed streptococci in the joint fluid. There were forty positive cultures in the 105 cases, ten staphylococcus and two gonococcus.

Suitable media were prepared, the aspirated joint fluid was directly implanted into the media, and the media immediately placed in an incubator. Cultures were examined daily and not discarded before thirty days had elapsed. As soon as a growth appeared, a subculture was made on human blood agar plates. The various media used are given.

A cytological study of joint fluid was made in sixty fluids. Tables are shown giving the number and variety of cells in positive and negative culture fluids. The total cells and the polymorphonuclear leucocytes were increased in the positive culture fluids. Neuropathic arthritis was similarly studied. Ten charcot joint fluids gave three positive cultures. The cell counts were similar to those found in the infectious arthritis group with negative cultures.—*F. G. Hodgson, M.D., Atlanta, Ga.*

ANIMAL EXPERIMENTS IN AN OPERATIVE PROCEDURE FOR FUSION OF THE SACRO-ILIAC JOINT. Willis C. Campbell. *Southern Med. J.*, XXIV, 186, Mar. 1931.

Indications for fusion of the sacro-iliac joint:

1. Failure of conservative measures.
2. Tuberculosis of the sacro-iliac joint.
3. Abnormalities and destructive changes shown by x-ray and not responding to treatment.
4. Persistent symptoms after conservative treatment, even if x-rays are negative.
5. In the case of wage earners,—where early return to work is essential.

The technique of the operation is described. Three adult dogs were operated upon. After three or four months the dogs were autopsied and the fusion examined. Good bony fusion was obtained.

Conclusions:

1. The technique is simple, with little or no surgical risk.
2. The procedure is entirely extra-articular.
3. Fusion causes no disability.
4. Clinical results and animal experiments prove the value and feasibility of the operation.
5. Except in cases of tuberculosis, conservative treatment should be first tried, then cases for operation carefully selected.—*F. G. Hodgson, M.D., Atlanta, Ga.*

SPONDYLOLISTHESIS, WITH SPECIAL REFERENCE TO THE INDUSTRIAL CASE. J. E. Stewart. *Southern Med. J.*, XXIV, 317, Apr. 1931.

More of these cases are being recognized now on account of the improved radiographs which are obtained of the lateral view of the spine. A separation of the neural arch is associated with this condition. Disarticulation or unlocking of the articular facets does not occur. There is an anteroposterior elongation of the fifth lumbar vertebra.

Contrary to former opinion this condition is now found more frequently in men than in women. Severe trauma is an important factor in its production. It is of fairly frequent occurrence.

Clinically, the lumbar segment is shortened, with lordosis; tender prominence of the first sacral spine with a hollow above it; sometimes a waddling gait. Symptoms are: pain in the low back, probably extending down the back or front of the thighs; inability to stand long on the feet, or lift heavy weights; restricted or painful motions of spine, and muscle spasms. In no instance was there damage to the cauda equina or nerve roots.

Treatment: Continuous recumbency on a Bradford frame or hard bed. Manipultions are usually unsuccessful. Operative fusion is advised for industrial workers. If refused, a non-elastic corset is applied and strain avoided.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

RESPIRATORY COMPLICATIONS AND THE SURGICAL PATIENT. Harold L. Foss and John H. Kupp. *Surg. Gynec. Obstet.*, LI, 798, Dec. 1930.

In this series there were performed 3,433 operations. Sixty (1.7 per cent.) developed pulmonary complications and of these twenty-five (.72 per cent.) died. Of every fifty-eight operations a pulmonary complication arose, and one patient of every 137 died of the complication.

Listing the specific complications by groups, he shows:

Lobar pneumonia, 3—1 died.
Bronchopneumonia, 16—10 died.
Bronchitis, 11.
Infarction, 15.
Embolism, 13. All died.
Massive collapse, 2.
Abscess, 1.

A comprehensive analysis is given in each group, determining the age incidence, time of onset, and relationship to type of operation and anaesthetic used.

The fact that most of the pneumonias are bronchial in type suggests that they are caused by minute emboli. Aspiration pneumonia is a less common factor than was previously thought. Therefore, the type of anaesthesia has little to do with the postoperative occurrence of pulmonary complications.

The authors conclude that embolism still plays the major part in postoperative pulmonary complications. They are less common in upper respiratory than in pelvic and abdominal operations. Other factors play a part besides the local irritation of anaesthesia, as shown by the incidence following local and spinal anaesthesia. The highest incidence is during the winter months.

The treatment should be hyperventilation during and after operation with carbon dioxid and oxygen, change in position every six hours postoperatively, curtailment of postoperative sedatives, bronchoscopic removal of mucus when collapse occurs, and the use of the oxygen tent.—*J. Kulowski, M.D., Iowa City.*

THE JUXTORETROPERONEAL ROUTE IN THE OPERATIVE TREATMENT OF FRACTURE OF THE MALLEOLUS WITH POSTERIOR MARGINAL FRAGMENT. Jean Gatellier. *Surg. Gynec. Obstet.*, LII, 67, Jan. 1931.

Two other approaches are mentioned, which utilize either a transachillean or transcalcanean route, by L-shaped incisions. The blood supply here is poor and gangrene may result.

The author suggests the following and reports a successful case thus operated upon: The incision is posterior to the fibula and curves under its tip. The tendons are released from their sheath and retracted forward. The lower fibular fragments are reduced by manipulation. It is sometimes necessary to make a small incision over the internal malleolus for its reduction. The fibula is replaced and held by a Parham band and the others with screws. The soft parts are restored and the wound closed.—*J. Kulowski, M.D., Iowa City, Iowa.*

THE CONSERVATIVE TREATMENT OF PREPATELLAR BURSITIS. Louis Carp. *Surg. Gynec. Obstet.*, LII, 87, Jan. 1931.

This is a study of twenty-seven cases of non-suppurative prepatellar bursitis, twenty-four of which had adequate follow-up observation.

The writer's treatment is aspiration of the fluid, followed by injection of two to five cubic centimeters half-strength three and five-tenths per cent. tincture of iodin. The area is then vigorously massaged and a firm bandage applied with the knee in complete extension. A cure is obtained in five to seven days. A second injection is seldom necessary.

Mention is made of the current treatment methods, including excision of the sac, incision and drainage, puncture, and scarification of the sac wall. Three men advise aspiration and chemical injection.

A complete table analysis of the cases accompanies this article. The important points in the summary are:

1. Sixty-five per cent. of the patients gave history of trauma.
2. Early, the fluid was bloody; later, amber-colored.
3. Cultures in eleven cases were sterile.

4. In slightly over one-half of the cases, reaccumulation of the fluid occurred in ten days; reaspiration but not reinjection was necessary as a rule.
5. Average follow-up was sixteen months. Three weeks was the average time for complete disappearance of the fluid.—*J. Kulowski, M.D., Iowa City, Iowa.*

PHYSIOLOGICAL RECONSTRUCTION OF A THUMB AFTER TOTAL LOSS. Sterling Bunnell. *Surg. Gynec. Obstet.*, LII, 245, Feb. 1931.

The author stresses the importance of maintaining the stereognostic function of the hand by preserving or allowing for new nerve supply in its reconstructive surgery.

The report of a case is given in detail. The patient lost his thumb at the carpo-metacarpal joint and the index finger through its proximal phalanx.

The procedure utilized the remaining ray of the index phalanx, by transplanting it *en masse* with its metacarpal portion to the position of the thumb. It had normal muscle attachments, blood and nerve supply. The second metacarpal was transplanted and fixed to the trapezium, skin flaps were utilized from the dorsum and volar surface of the hand. Meticulous dissection and anchorage of the thenar group of muscles was necessary. An excellent functioning hand resulted.

A brief review is given of the various hand reconstructive procedures used, mention being made of phalangization, osteotomy of the index and little fingers and rotation for opposing action, skin grafts and bone grafts, substitution from a distance and changing the direction of the intact thumb for loss of index and long fingers.—*J. Kulowski, M.D., Iowa City, Iowa.*

A METHOD FOR THE PRE-OPERATIVE DETERMINATION OF THE BEST FUNCTIONAL POSITION FOR AN ANKYLOSED HIP. Alfred O. Adams. *Surg. Gynec. Obstet.*, LII, 261, Feb. 1931.

From the author's experience the maximum functional position for a unilateral ankylosis of the hip in children is twenty to twenty-five per cent. flexion, less than eighteen degrees of abduction, and slight external rotation.

Several methods of measuring the hip deformities are discussed. When the real shortening exceeds the apparent, then abduction must be increased. When the opposite is true, adduction is necessary. He measures abduction on carefully taken x-rays by a line through the inferior border of the sacro-iliac joints which intersects with a line through the longitudinal axis of the femur.

The width of the pelvis is important in the mechanism of compensation for shortening. The wider the pelvis the more shortening can be taken care of, or, in other words, the wider the pelvis the less the abduction that is necessary, providing the rate of growth of the two extremities is the same.

The author predetermines the optimum position by first determining the real shortening; the apparent shortening to be obtained by adequate abduction should be one-half inch less. By referring to Lovett's table under the proper pelvic width, the abduction in degrees is given.

For the optimum flexion the distance from the table to the leg is measured at a point twenty-four inches from the trochanter; by referring to Kingsley's table, the result is given.—*J. Kulowski, M.D., Iowa City, Iowa.*

SURGICAL TREATMENT OF NEUROGENIC CONTRACTURES. Otfried Foerster. *Surg. Gynec. Obstet.*, LII, 360, Feb. 1931.

A neurogenic contracture is one due to abnormal innervation by pathological irritation of peripheral motor nerve fibers, of afferent peripheral nerve fibers, or by pyramidal-tract lesions.

The treatment of the first two types is a local surgical correction at the site of irritation. The pyramidal-tract type is amenable mainly to three types of surgical measures,—operations on the muscles and tendons, total or subtotal resection of motor nerves, and resection of the posterior spinal roots. Sympathetic ramisection is not given serious consideration, because he does not believe it to have sufficient physiologic basis.

The pyramidal-tract contractures are discussed in some detail. The best results are obtained in carefully selected cases of the lower extremity. Root resection is advisable only in the severe paraplegias with more or less generalized contractures. Extrapyramidal lesions are not relieved by root resection. His other procedures deal mainly with motor nerve resection (subtotal), tendon plasties, and some tendon transplantations. He seldom advises complete denervation of any muscle group, and uses the tendon reflexes as guides controlling the amount of nerve resection.—*J. Kulowski, M.D., Iowa City, Iowa.*

SPLINT GRAFTS IN THE TREATMENT OF DELAYED AND NON-UNION OF FRACTURES. D. B. Phemister. *Surg. Gynec. Obstet.*, LII, 376, Feb. 1931.

The author first states that osseous tissue, regardless of the portion of the bone in which it is located, behaves the same in its reparative response to injury and loss of substance. Union will take place between graft and host no matter what the contiguous portions are. Thus the endosteum of the graft will unite to the periosteum of the host and *vice versa*, when bridged across the fracture line. Once a bony bridge has been affected, the remaining intermediary callus will ossify.

Mention is made of the three commonly used types of bone grafts,—intramedullary, inlay, and onlay or splint grafts. They are all about equally efficacious, save perhaps the intramedullary. But these are all more or less complex and cause a considerable amount of traumatism.

Phemister gives special consideration to those cases of non-union or delayed union in which there is satisfactory alignment, and for which the purpose of the graft is not splinting but a source of bridging and osteogenesis. In such cases small osteoperiosteal grafts may be laid across the fracture line with or without disturbing the callus, as the case may be. This is a satisfactory simple method; he also concludes that the Haglund sliding graft may be used in fresh fractures. He does not feel that intramedullary grafts are suitable *per se*, but that a broad inlay graft which fills the medullary canal and also the slot in the cortex is proper in fractures of the large bones.—*J. Kulowski, M.D., Iowa City, Iowa.*

THE STERILITY OF CATGUT IN RELATION TO HOSPITAL INFECTIONS; WITH AN EFFECTIVE TEST FOR THE STERILITY OF CATGUT. Frank H. Meleney and Mabel Chatfield. *Surg. Gynec. Obstet.*, LII, 430, Feb. 1931.

In a recent study of 174 specimens of catgut sent to the writers from twelve clinics, twelve and one-half per cent. were found to be contaminated with spore-forming bacteria, including the common gas gangrene organisms. None of the specimens yielded the pyogenic foci. A review of the literature on this subject revealed that the Germans found eighty per cent. of catgut investigated contaminated; a recent British investigation resulted in the legal requirement that firms dealing in catgut conform to certain sterility tests upon the final product. This country has no laws regarding this important question.

Catgut is sterilized by heat, by chemicals, or by bath. In all these methods the spore formers may escape because the margin of safety between destruction of the bacteria and the destruction of the catgut is so small.

A rigid test has been devised for the detection of catgut contamination, which now awaits adoption by the proper authorities.—*J. Kulowski, M.D., Iowa City, Iowa.*

EPIPHYSEAL CHONDROMATOUS GIANT-CELL TUMORS OF THE UPPER END OF THE HUMERUS. E. A. Codman. *Surg. Gynec. Obstet.*, LII, 543, Feb. 1931.

Nine tumors, involving the upper end of the humerus in the region of the tuberosities, are discussed. Codman believes this type to be benign, although several of this group (registry study) have been reported as sarcomas elsewhere in the literature, by excellent workers in this field.

The nine cases present a definite clinical entity and are presented as such:

They lie in the angle between the epiphysis of the head and the tuberosities. The articular cartilage is left alone (just as a sarcoma in the lower end of the femur) contrary to the rules of giant-cell tumors elsewhere. They do not present the usual trabeculated appearance, but a sort of "cotton wool" look. They are sharply demarcated, and a dense buttress of cortical bone is usually found beneath it. None of this series was larger than a normal humeral head.

Microscopically, the cells are of a low-grade cartilage and epithelial cells (this picture may be present in sarcoma).

The ages of the patients were from twelve to twenty-four years. The tumors probably came from the epiphyseal cartilage. The symptoms were present a comparatively long time and early simulated subacromial bursitis. All the patients are still alive. The treatment should be mild x-ray irradiation or resection of the tumor, followed by suture of the short rotators to the defect in the head of the humerus, as was done in one case.—*J. Kulowski, M.D., Iowa City, Iowa.*

THE IMMEDIATE TREATMENT OF INJURIES OF THE HAND. Sumner L. Koch. *Surg. Gynec. Obstet.*, LII, 594, Feb. 1931.

Careful examination for determination of the complete extent of the injury is of paramount importance. Lesions of the nerves and tendons are easily determined from one's anatomical knowledge. The hand is then carefully prepared without the use of antiseptics or other stains.

1. Superficial injuries: Débridement or skin graft wherever possible should be done.
2. Tendon injuries: If seen after four hours, primary repair is unwise. If no sheath is present, localization of the infection is likely. Suture repair of the tendon may best be done secondarily, especially if a tendon sheath is present.
3. Nerve injuries: Here again immediate repair and dissection is not necessary.
4. Bone and joint: Splinting and early mobilization is advised.
5. Small penetrating wounds: This type should never be sutured, but should be laid open widely if there is any suspicion of gas infection, etc. Dakinization, anti-gas-gangrene serum, tetanus antitoxin should be used as a routine.

Operative needle wounds are best treated by wet dressings, immobilization, and rest in bed. Early incision may and does lead to death.—*J. Kulowski, M.D., Iowa City, Iowa.*

RUPTURE OF THE SUPRASPINATUS TENDON. Ernest A. Codman. *Surg. Gynec. Obstet.*, LII, 2A, 579, Feb. 15, 1931.

The aim of the author is to call attention to the existence of rupture of the supraspinatus tendon and to describe signs and symptoms of this clinical entity so that it may be recognized early and have proper treatment. The author has reported upon the diagnosis in forty-four cases and was correct in thirty-eight. In 500 cases of shoulder injury he has made this diagnosis in 122 instances. The claim for frequency of the occurrence of this disability is further supported by autopsy examinations of 100 shoulder joints in elderly subjects by Dr. Akerson, who found rupture of the supraspinatus tendon in thirty-nine instances.

Rupture of this tendon produces prolonged disability. After such an injury to the shoulder the patient may attempt work but painful nights following work usually prevent continued occupation unless little abduction at the shoulder is necessary in the patient's work.

Signs in a typical case are described. Later than three weeks from injury there is atrophy of the spinati making the scapular spine prominent. The deltoid may be slightly atrophic at first and later hypertrophied. Shoulder motion is not limited by adhesions; however, muscle spasm may limit the motion at first. The arm may be passively raised but may not be actively abducted if there is a complete tear. If the rupture is not so severe, the patient may be able to raise the arm to a vertical position

but the normal scapulohumeral rhythm will be lost, the scapular and humerus moving together for a way and then after a jog and wince the humeral joint will move and the arm be elevated vertically. The jog comes about with crepitus as the tuberosity of the humerus moves under the acromion. In the stooping position with gravity eliminated the above syndrome may be absent.

Upon inspecting the patient as he stands with arms at the sides and elbows pulled backward, the tuberosity of the humerus may be unduly prominent on the injured side and a sulcus may be seen proximal to the tuberosity where the tendon should be. In the sulcus there is usually a tender spot which rotates with the humerus and disappears under the acromion when the humerus is abducted. Diagnostic signs are present when the arm descends from the upright position. The shoulder blade is usually fixed to the humerus till the arm is horizontal; then with wincing, the muscles are relaxed; the patient leans to the affected side; and the arm drops to the side through ninety degrees of scapulohumeral motion. Another sign is evident when both arms are elevated: a change in contour of the deltoid region on the affected side, due to an alteration in the folds of the skin between shoulder and neck caused by joint fluid being driven into the subdeltoid region caused by the tenseness of the lower portion of the capsule.

Operative repair has not been done soon after injury in the author's cases, and though the results have been fairly good he feels that immediate repair would have resulted in more prompt and more satisfactory end results.

Trauma certainly is important in the etiology but age plays an important part, as he has not found the condition at operation earlier than thirty-eight years of age. Loss in elasticity of the tendons is probably a factor. The lesion is common in working people and hence probably related to repeated strains. The author thinks it likely that tendinitis precedes the rupture and thinks it probable that the calcareous lesions in the spinati tendons, wrongly termed "calcaneous subacromial bursitis", leave a defect in the tendons which may predispose to tendinous rupture.—*Hugh Jones, M. D., Los Angeles, Calif.*

ZUR LOKALISATION DER SPONDYLOPATHIA DEFORMANS (In Reference to the Localization of Spondylopathia Deformans). Kurt Plesmann. *Ztschr. f. Orthop. Chir.*, LIII, 242, 1930.

The author found, as did Schanz, that in extensive osteo-arthritis of the spine with marked spur formation, a spur-free channel corresponding in length and breadth to the aorta is present in cadavera examined.

He differs with Schanz in considering the aorta as a support for the spine, having found no rupture of the aorta at a corresponding level in any of forty fractured spines examined. One rupture of the aorta at the isthmus aortae accompanied a fracture of the first lumbar vertebra. This suggests that the aorta is not stiffly spanned, but quite mobile, and consequently is not capable of furnishing support to the vertebral column. The absence of spur formation is possibly connected in some way with the pulsation of the aorta.—*J. E. Milgram, M.D., Iowa City, Iowa.*